RSET

RAJAGIRI SCHOOL OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

Curriculum Book (KTU-2015 Scheme)

RSET VISION

To evolve into a premier technological and research institution, moulding eminent professionals with creative minds, innovative ideas and sound practical skill, and to shape a future where technology works for the enrichment of mankind.

RSET MISSION

To impart state-of-the-art knowledge to individuals in various technological disciplines and to inculcate in them a high degree of social consciousness and human values, thereby enabling them to face the challenges of life with courage and conviction.

DEPARTMENT VISION

To evolve into a centre of excellence by imparting professional education in mechanical engineering with a unique academic and research ambience that fosters innovation, creativity and excellence.

DEPARTMENTMISSION

- *To have state-of-the-art infrastructure facilities.*
- *To have highly qualified and experienced faculty from academics, research organizations and industry.*
- *To develop students as socially committed professionals with sound engineering knowledge, creative minds, leadership qualities and practical skills.*

PROGRAMME EDUCATIONAL OBJECTIVES

PEO 1: Demonstrate the ability to analyze, formulate and solve/design engineering/real life problems based on his/her solid foundation in mathematics, science and engineering.

PEO 2: Showcase the ability to apply their knowledge and skills for a successful career in diverse domains viz., industry/technical, research and higher education/academia with creativity, commitment and social consciousness.

PEO 3: Exhibite professionalism, ethical attitude, communication skill, team work, multidisciplinary approach, professional development through continued education and an ability to relate engineering issues to broader social context.

PROGRAMME OUTCOMES

1) **Engineering Knowledge:** Apply the knowledge of Mathematics, Science, Engineering fundamentals, and Mechanical Engineering to the solution of complex engineering problems.
2) **Problem analysis:** Identify, formulate, review research literature, and analyze complex Engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and Engineering sciences.
3) **Design/development of solutions:** Design solutions for complex Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4) **Conduct investigations of complex problems:** Use research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5) **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex Engineering activities with an understanding of the limitations.
6) **The Engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional Engineering practice.
7) **Environment and sustainability:** Understand the impact of the professional Engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and the need for sustainable developments.
8) **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the Engineering practice.
9) **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10) **Communication:** Communicate effectively on complex Engineering activities with the Engineering Community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11) **Project management and finance:** Demonstrate knowledge and understanding of the Engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multi-disciplinary environments.
12) **Life -long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life- long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES

Mechanical Engineering Programme Students will be able to:

1) Apply their knowledge in the domain of engineering mechanics, thermal and fluid sciences to solve engineering problems utilizing advanced technology.
2) Successfully apply the principles of design, analysis and implementation of mechanical systems/processes which have been learned as a part of the curriculum.
3) Develop and implement new ideas on product design and development with the help of modern CAD/CAM tools, while ensuring best manufacturing practices.

KERALA TECHNOLOGICAL UNIVERSITY

CET Campus, Thiruvananthapuram, Kerala-695016

ORDINANCE

For

Bachelor of Technology B.Tech./B.Tech. (Honours)

In exercise of the Powers conferred under Clause 44 of the Ordinance, the Executive Committee of the University hereby promulgate the Ordinance for the University for the Academic Year 2015-2016.This Ordinance shall come into effect from the date of its publication in the Gazette.

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1. Admission to Bachelor of Technology / B.Tech. / B.Tech. (Honours)

a. Eligibility for admission to the B.Tech., programme, admission policy and procedure shall be decided from time to time by following the guidelines issued by the Government of Kerala and the Government of India and other statutory body such as AICTE.

b. Subject to Clause 1(a), Admission to B.Tech., shall be based on the guidelines given by the State and Central Governments on reservation. Candidates for admission to B.Tech., programme shall have passed the Higher Secondary Examination, Kerala or 12^{th} Standard V.H.S.E., C.B.S.E., I.S.C or any other examination considered equivalent to the above mentioned ones. Other eligibility criteria for admission is currently prescribed by the Government of Kerala through Government orders which is based on the entrance examination conducted by the Commission for Entrance Examinations, Government of Kerala and the marks in the qualifying examination subject to the relaxations allowed for backward classes and other communities as specified from time to time.

c. The Branches of study and number of students admitted are to be based on the approval by the All India Council for Technical Education and the Kerala Technological University.

d. Notwithstanding all that is stated above, the admission policy may be modified from time to time by the University, particularly to confirm to directions from the Government of Kerala and the Government of India.

e. The B.Tech., / B.Tech. (Honours) programme is a credit based programme. The duration of the B. Tech / B. Tech (Honours) programme will normally be four academic years spanning 8 semesters**.** The maximum duration shall be six academic years spanning 12 semesters.

2. Examination

a. At the end of the semester, end semester examination will be conducted in all lecture based courses offered in the semester and will normally be of three hours duration, unless otherwise specified. Supplementary examinations shall be conducted before the commencement of the next semester, for students who are eligible and have registered for them.

b. Students, who have completed a course but could not write the end semester examination for valid reasons like illness or personal exigencies, are allowed to write the supplementary examination or the end semester examination at the next opportunity and earn the credits without having to register for the course again provided they meet other eligibility criteria.

c. The main eligibility criteria for the end semester examination are attendance in the course, internal marks and no pending disciplinary action. The minimum attendance for appearing for the end semester examination is 75% in each course. Further, the internal evaluation marks in the course should be 45% or above. Students who do not meet these eligibility criteria are awarded an FE grade and have to register for the course again.

d. Students who could not write the end semester examination due to health reasons or other exigencies can register for the supplementary examination, with the approval of the principal provided they have 45% or above marks in the internal evaluations for the course. Candidates who received F grade can also write the supplementary examination. Grades awarded in the supplementary examination will be taken as the end semester grades in these courses.

3. Eligibility for Award of Degree

The award of B. Tech. / B. Tech. (Honours) degree shall be based on the recommendation of the Academic Committee and the approval of the Board of Governors and in accordance with the academic regulations, if any, issued for the said purpose by the University.

Award of B. Tech. Degree

A student will be eligible for the award of B. Tech. Degree of the University on satisfying the following requirements.

i) Earned credits for all the core courses and the Project.

ii) Earned the required minimum credits as specified in the curriculum for the branch of study.

iii) No pending disciplinary action.

4. Fee charged by the University

Fee charged for the programme shall be decided by the University from time to time and informed to all concerned for compliance.

5. Discipline of the student – Action against breach of discipline

Every college shall have a Student's Welfare Committee and a Disciplinary Action Committee, constituted by the Principal of the college. Each college should have a Grievance Redressal and Appeals Committee constituted by the Principal to address the grievances of the students and to consider their appeals on any decisions made by the college. Details on the constitution and terms of reference are outlined in 7-x, 7-y, and 7-z.

6. **Breach of guidelines and unfair practices in Examinations**

These are viewed seriously and appropriate actions are to be taken by the colleges as detailed in 7-x.

a. Language of Instruction and Examination.

Unless otherwise stated, the language of instruction and examinations shall be English.

b. Academic Calendar.

The University shall publish in its website the academic calendar for every academic semester indicating the commencement of the semester and beginning of instruction. It will specify the course registration and enrolment dates, the schedule for mandatory internal tests for theory courses, dates by which laboratory/practical evaluations are to be completed, date for finalization of internal marks, last instruction day in the semester, planned schedule of end semester examinations and result declaration as well as approved holidays falling within the semester. Schedules for the supplementary examinations and result declaration dates are to be included in the calendar. Summer course schedule and result declaration have also to be indicated in the calendar. Additionally colleges may publish their academic calendar, in line with the University academic calendar, indicating other schedules and events they plan to conduct during the semester.

c. Branches of B. Tech. Programmes.

The Branches of B. Tech. /B. Tech. (Honours) programme offered by the University are listed separately at the end of this Ordinance

d. B. Tech. Programme Structure

i) B. Tech. / B. Tech. (Honours) programme in all branches of study is structured on a credit based system following the semester pattern with continuous evaluation allowing flexibility for students to decide on the duration of programme completion.

ii) The duration for the B. Tech. /B. Tech. (Honours) programme in all branches of study, will normally be 8 semesters.

iii) The maximum duration shall be six academic years spanning 12 semesters.

iv) Each semester shall have 72 instructional days, followed by end semester examinations.

v) A student can opt for B.Tech. (Honours) at the end of the fourth semester.

vi) The curriculum of any branch of the B. Tech. programme is designed to have a minimum of **180** academic credits and 2 additional pass/fail credits, for the award of the degree.

vii) The University follows Credit System and Credits are apportioned among the following knowledge segments.

B.Tech. Programme.

Knowledge Segments		Credits	
Basic Sciences	]	10	[8 Theory+ 2 Labs]
Mathematics		16	
Humanities		9	
Basic Engineering		29	[25 Theory +4 Labs]
Professional Engineering		89	[80 Theory +9 Labs]
Electives		15	
Seminar		2	
Comprehensive Viva		2	
Design Project		2	
Project		6	
Total Academic Credits:		**180**	
Student's Activities		2	[Audit-Pass/Fail]
Total credits for B.Tech. Degree		182	

Credits are assigned to courses based on the following general pattern.

One credit for each lecture hour per week for one semester
One credit for each tutorial hour per week for one semester

One credit for each laboratory/ practical session of 2 or 3 hrs, per week for one semester

viii) In a semester normally up to six lecture based courses and three laboratory/practical courses, carrying a maximum credit of 26, could be offered.

ix) University may allow students to transfer credits they have earned at other Universities and Academic Institutions, as per the guidelines given by the Academic Committee and approved by the Board of Governors.

x) Student Activities Points:

To be an engineer capable of competing globally, in addition to technical knowledge and skills, students should develop excellent soft skills, nurture team work and leadership qualities and have an entrepreneurial and trail blazing outlook. To achieve this, in addition to academics, students are to actively engage in co-curricular and extra-curricular activities. For such activities, points are allotted. On getting a minimum of 100 activity points the student passes the course and earns 2 credits which do not count for the CGPA but mandatory for the award of the degree. Listing of these activities and the maximum points that could be earned by engaging in them are given at the end of this document. Additional activities could be included in the list with the approval of the Academic Committee.

e. Curriculum, List of Courses and Syllabi

i) Every branch of study in the B.Tech., programme will have a curriculum, list of courses, syllabi and course plans approved by the Academic Committee of the University.

ii) Courses are categorized as Core Theory (CT), Core Practice (CP) and Electives (EL).

iii) Each course has a course number. Course number includes the offering department or knowledge segment code and a three digit number. Knowledge segment code is used when a course is offered by any one or more departments with the same course content and syllabus. Details on this are given under Rule, RU-1.

f. Faculty Advisor/Counsellor

All students shall have faculty advisors whose role will be:-
To guide and help students on academics
To monitor their progress in academics and advise them
To counsel them and hand-hold them in any difficulty

g. Course Registration and Enrolment

It is mandatory for students to register for the courses they want to attend in a semester. Students admitted freshly to the first semester, are advised to register for all courses listed for the semester. However they do not have to enrol for the

semester. All other students are required to register at the end of the semester for the courses they desire to take in the coming semester. They have to enrol for these courses at the beginning of the new semester, based on the previous semester results. This allows them to make changes in the list of courses already registered for. Before enrolment, students should clear all dues including any fees to be paid and should not have any disciplinary issues pending. The dates for registration and enrolment will be given in the academic calendar. Any late registration or enrolment, allowed up to 7 working days from the stipulated date, will attract a late fee.

A student can withdraw from a course or substitute one already registered by another on valid reasons with the approval of the faculty advisor. However this has to be done within seven working days from the commencement of the semester.

The maximum number of credits a student can register in a semester is limited to 26.

h. Course Completion and Earning of Credits

Students registered and later enrolled for a course have to attend the course regularly and meet the attendance rules of the university [RU-2] and appear for all the internal evaluation procedures for the completion of the course. Credits for the course are earned only on getting a pass grade in the composite evaluation.

i) Core courses, Prerequisites and Electives

All courses listed in the curriculum, other than the electives, are core courses. Earning credits in the core courses is mandatory for the B. Tech. degree. For electives, failure to earn credits does not necessarily require repeating the course. Instead another approved elective is permitted as a replacement course by the faculty advisor concerned. For some courses there could be a prerequisite course completion requirement for registration.

J) **Summer Courses**

Students who could not earn the required minimum credits at the end of the second or fourth semester have two options to continue with the studies. They may register again for the courses, when they are offered in the next academic year. However, there is also a provision to run summer courses in failed courses for these students who may register and attend the course and write the final examination. This provision is only for students who have got 45% or more in the internal evaluation for the courses they attended in the regular semester.

Students should have 75% attendance in the summer course to write the examination.

For the final grading their internal evaluation marks obtained in the regular semester in which they had undergone the course shall be applicable. Summer courses are to be conducted for a minimum of 20 contact hours for each course. Summer courses are to be offered only at the end of the second and fourth semesters for the courses covered till that semester. They will be conducted either by all colleges or only by some, depending on the number of students registering for them. Details of summer courses planned will be announced by the colleges after the declaration of the even semester results. Final examination for summer courses will be conducted by the University. Based on the availability of faculty and the number of students opting for courses, it will be the prerogative of the colleges to decide on the summer courses to be offered.

Options for the fifth and higher semesters

For higher semesters, i.e., fifth semester onwards, summer courses are not offered. Failed students who have less than 45% marks in internal assessments have to register again for the course in the regular semester in which it is offered and complete the course as per the regulations and appear for the end semester examination. Failed students having 45% marks or more in internal assessments have the option to register again for the course as mentioned above or register only for the end semester examination without attending the course again. A separate registration format will be available for this. This option is available in all semesters.

k) **Contact Courses**

If a student has to earn credits only just for one course to qualify for the degree after completing eight semesters of study, the college concerned may offer a contact course on a written request by the student. The contact course is considered as fresh registration and is to be offered by the teacher concerned who shall conduct the internal evaluation procedures and allot the marks as per the regulations. Minimum contact hours for the course shall be 20. The final examination will be conducted by the college and shall be monitored by the external academic auditor. Question paper for the examination will be given by the Controller of Examination. No grade above C shall be given for a contact course.

l) Academic Assessment/Evaluation

Academic Evaluation of Courses

University follows a continuous academic evaluation procedure.

Academic evaluation procedure and corresponding weights are as follows:-

a) For theory courses: - 1/3rd weightage for internal evaluation and 2/3rd for end semester examination.

For convenience, the maximum marks for internal evaluation and end semester examination for theory courses are fixed as 50 and 100 respectively.

Scheme of evaluation is as follows.

i) Two internal tests each of 20 marks and of one hour duration. (Internally by the College)

ii) Tutorials/Assignments/Mini Projects carrying 10 marks. (Internally by the College)

iii) End Semester examination carrying 100 marks. (Conducted by the University)

All the above evaluations are mandatory requirements to earn credits.

Students who have missed either the first or the second test can register with the consent of the faculty and the Head of the Department (HOD) concerned for a re-test which shall be conducted soon after the completion of the second test, but before the end semester examination. The re-test will cover both first and second test course plans. Those who have missed both the tests are not eligible to appear for the end semester examination.

However if one misses both tests due to medical reasons or other personal exigencies, based on genuine evidence, a single test of 2 hour duration for 40 marks will be conducted covering the whole syllabus, before the end semester examinations. Decision on this will be taken by the Principal and verified by the external academic auditor.

b) For Laboratory /Practical /Workshop courses

i)	Practical records /Outputs	60 marks	(Internally by the College)
ii)	Regular class Viva	10 marks	(Internally by the College)
iii)	Final written test/quiz	30 marks	(Internally by the College)

All the above assessments are mandatory to earn credits. If not, the student has to complete the course/assessments during his free time in consultation with the faculty members. On completion of these, grades will be assigned. In case the Practical /Laboratory/Workshop courses are not completed in the semester, grade I (incomplete) will be awarded against the course and the final grade will be given only after the completion of the course/assessments.

c) Comprehensive Examination

As students appear for placements from seventh semester onwards, comprehensive examination is to be completed in the sixth semester. This examination will be a written cum oral examination covering broadly all courses so far completed [RU-5].

d) Seminar

Each student has to give a seminar on a professional topic of current interest in consultation with the faculty member in charge of the seminar in the Department. The seminar will be evaluated based on RU-6

e) Design Project

Each student or a group of students has to take up a design project. The project topic could be arrived at in consultation with any faculty member in the department. The Evaluation of the project is to be done in two stages. Two project progress evaluations each carrying 20 marks and a final report evaluation and presentation of the project for 60 marks. The project supervisor and two other faculty members from the same or any other department, nominated by the Head of the Department form the evaluation board.

f) Final Semester Project

Students, either individually or in a small batch not exceeding four, have to do a project approved by their faculty supervisor.

Evaluation scheme is given below:-

i)	Two progress assessments	20%	by the faculty supervisor/s
ii)	Final Project Report	30%	by the Assessment Board
iii)	Project presentation and Viva	50%	by the Assessment Board

If the project work is not completed satisfactorily, the student has to put in more work and appear again for assessment on a specified date, not earlier than one month after the first evaluation. If the student fails in the project, a fresh registration for the project for one semester is mandatory.

The project assessment board shall consist of the following members.

Chairman: Head of the Department

Members: Project supervisor/s of the student

One faculty member from the Department

One faculty member from a sister Department

An external expert, either from an academic/research institute or industry

m) Eligibility to Continue

A student has to earn a minimum number of credits in a semester to be eligible to register for the new courses offered in the next semester. In odd semesters if this requirement is not met, the student is to be forewarned and allowed to continue to the next even semester. However at the end of even semesters this requirement will be strictly implemented. Summer courses are offered to those who do not satisfy this norm after the 2^{nd} as well as the 4^{th} semesters. Students who do not meet this requirement are not permitted to register for new courses in the higher semesters. They have to register for the failed courses in normal semesters in which

they are offered subject to the limitations imposed by the ordinances and course timetable.

Action plan, for dealing with course arrears in theory courses at the end of each semester to continue with the programme, is given below. Faculty advisors shall monitor advice and support the students in this. Students should be informed about the minimum cumulative credits requirement to register for higher semester courses.

Eligibility Criteria for Registering for Higher Semester Courses

Semester	Allotted Credits	Cumulative Credits	Minimum cumulative credits required to register for courses in higher semesters
First	24	24	Not insisted
Second	23	47	35
Third	24	71	Not insisted
Fourth	23	94	80
Fifth	23	117	Not insisted
Sixth	23	140	126
Seventh	22	162	Not insisted
Eighth	18	180	

n) Course Committees and Class Committees

These committees are to be in place in each college affiliated to the University.

a) Course Committee

This is for common courses (electives are excluded) offered to students admitted for the B. Tech. programme irrespective of their branch of study. Each of such courses will have a course committee constituted by the Principal of the college.

The chairman of the course committee shall be a senior faculty member not offering the course.

Members:-

i) All teachers offering the course.

ii) Four student representatives nominated by the Principal.

b) Class Committee

Beginning from the third semester, all branches of study will have class committees for every semester constituted by the respective Heads of Departments.

The chairman of the committee shall be a senior faculty member who does not offer any course during that semester.

Members:-

i) All faculty members teaching courses in that semester.
ii) Two student representatives nominated by the head of the Department.

The course committees and class committees shall meet at least thrice in a semester – the first at the beginning of the semester, the second and the third after the first and the second internal tests respectively. Both committees should monitor the conduct of the courses, adherence to the course plan and time schedule, completion of the syllabus, standards of internal tests, evaluation process and difficulties faced by the students and take suitable remedial actions at the appropriate time. At the end of the semester, the committee should meet without student representatives to review the conduct of the course and finalize the internal assessment marks and approve them.

o) Eligibility for writing the end semester examination and for grading

Students with 45% or more marks in internal assessment in a course shall only be permitted to write the end semester examination in that course. Those with less than 45% internal marks shall be awarded FE grade and have to register for the course again.

A student should have a minimum of 45% marks in the end semester examination to be eligible for grading in a course. Otherwise he/she will be considered to have failed in the course and an F grade will be awarded.

Internal marks given to the students who got 45% marks or more in the end semester examination shall be regulated in line with the end semester examination performance. Internal mark percentage shall not exceed 25% over the end semester mark %.

(For example if the end semester mark % is 45, then the maximum internal mark % is to be 45+25 = 70 %.)

In case the student writes the supplementary examination, the mark got in that will be taken into consideration for regulating the internal marks.

Those who have more than 45% marks in the end semester examination are awarded the grade based on both internal assessment and end semester examination marks. A student earns credits for a course if the grade is P or above.

p) Award of Grades

Grading is based on the % marks obtained by the student in a course, as given in 7q.
The grade card will only give the grades against the courses the student has registered.

Semester grade card will give the grade for each registered course, Semester Grade Point Average (SGPA) for the semester as well as Cumulative Grade Point Average (CGPA).

q) Grades and Grade Points

Grades and Grade Points as per UGC guidelines is to be followed by the University

Grades		Grade Point (GP)	% of Total Marks obtained in the course
O	(Outstanding)	10	90% and above
A^+	(Excellent)	9	85% and above but less than 90%
A	(Very Good)	8	80% and above but less than 85%
B^+	(Good)	7	70% and above but less than 80%
B	(Above Average)	6	60% and above but less than 70%
C	(Average)	5	50% and above but less than 60%
P	(Pass)	4	45% and above but less than 50%
F	(Fail)	0	Less than 45%
FE		0	Failed due to eligibility criteria [7-o]
I			Course Incomplete

SGPA and CGPA are calculated based on the above grading norms and are explained at the end of this document.

r) **Academic Auditing**

The University shall have a detailed academic auditing procedure in place comprising of an internal academic auditing cell within the colleges and an external academic auditing for each college. The internal academic auditing cell in each college shall oversee and monitor all the academic activities including all internal evaluations and examinations. This cell is to prepare academic audit statements for each semester at regular intervals. These reports are to be presented to the external academic auditor approved by the University, who will use it as a reference for his independent auditing and for the final report to the University.

Academic auditing shall cover:-

i) Course delivery covering syllabus, adherence to course plan, quality of question papers for internal examinations, internal evaluation, laboratory experiments, practical assignments, mini projects and conduct of practical classes and their evaluation.

ii) Co-curricular and Extra-curricular activities available for students, their organization and the mechanism of monitoring of activities points earned by the students.

iii) Academic functioning of the college encompassing students, faculty and college administration covering punctuality, attendance, discipline, academic

environment, academic accountability, academic achievements and benchmarking.

s) Break of Study

A student may break study for a maximum duration of two semesters, preferably in one academic year, to initiate start-up ventures, product development etc. This is however permitted only on successfully completing the courses listed out in the first four semesters. Request for this with ample evidence to the seriousness of the venture should be forwarded to the college principal for approval. [RU-3]

Break of study on serious health reasons is also permitted with the approval of the college Principal. [RU-3]

All such cases of break of study are to be reported to the University. In both the cases, the maximum duration for completing the B. Tech. programme will still be twelve semesters.

t) Revaluation and Grade Improvement

There is no provision for revaluation of the end semester answer books or for improving the grade.

However, the student is permitted to check the answer books of the end semester examination after the results are declared. Any discrepancy in evaluation could be brought to the notice of the teacher concerned who will initiate appropriate action on this. The decision of the Controller of Examination shall be final on this.

u) Grade Cards

Students who have written the end semester examination will be given the grade cards for the registered courses, in every semester by the respective colleges. On earning the required credits for the degree, a consolidated grade sheet for the B. Tech programme will be given by the University.

v) B. Tech Degree

B.Tech. degree will not have any classifications like distinction or first class.

w) B. Tech. (Honours)

Accredited departments in institutions, having at least two post graduate programmes, may offer B. Tech. (Honours). It should be noted that students with a CGPA above 8 at the end of the fourth semester and having no credit arrears only are eligible for this option. As only selected institutions may have this provision, students cannot demand this or move later to an institute where this is available. Students have to earn 12 additional credits to get B. Tech (Honours). Furthermore their CGPA at the

end of the programme should be 8 or higher. Those who opted for B. Tech (Honours) but unable to earn the required additional credits in 8 semesters or whose final CGPA is less than 8 shall automatically fall back to the B. Tech. programme. However, additional course credits and the grades thus far earned by them will be shown in the grade card but not included for the CGPA.

x) Academic Discipline and Malpractices in Examinations

Every student is required to observe discipline and decorous behaviour.
Any act of indiscipline, misbehaviour and unfair practice in examinations will be referred to the **Disciplinary Action Committee** (**DAC**). Malpractices in examinations shall be viewed seriously and any such incident observed or reported by a faculty member or an invigilator associated with the examinations shall be reported to the Principal who in turn shall refer it to DAC. On the basis of the report and evidence available or gathered, DAC shall immediately initiate an enquiry giving the concerned student a chance to explain his/her case. Based on this the committee shall recommend the course of action in line with the guidelines formulated for this by the Controller of Examination of the University and forward it to the Principal for action.

Actions are to be based on the severity of the offence and are to be dealt with, on a course basis. Guidelines on this shall be given by the Controller of Examination which is to be followed by the Disciplinary Action Committee of the college.

The student may appeal to the Grievances and Appeals Committee for a relook on the matter. Based on the committee's report, the Principal shall take a final decision on the matter.
DAC shall be headed by a department head and shall have three other faculty members drawn from different departments as members. In case of malpractices in end semester examinations, the report given by the college DAC and the action taken by the Principal shall be intimated to the Controller of Examination of the University

y) Student's Welfare Committee

Every college shall have a Student's Welfare Committee, constituted by the Principal of the college. This committee shall have at least three faculty members as members and the chairman shall be a senior faculty member in the rank of a Professor. This committee is entrusted with the task of looking after the welfare of the students by taking appropriate steps with the concurrence of the principal.

z) Grievances and Appeals Committee

Each college should have a Grievances Redress Committee constituted by the Principal to address the grievances of the students and to consider their appeals on any decisions made by the college. This committee consisting of at least three faculty

members and chaired by a senior professor shall look into student's grievances and appeals and give its recommendations to the Principal for action.

8) Amendment to Ordinance/ Regulations/Rules

Notwithstanding all that has been stated above, the University has the right to modify any of the above Ordinance/Rules/regulations from time to time.

RULES:

RU-1 Course Code and Course Number

Each course is identified by a course code and a three digit number. The two letter code refers to the department offering the course or the knowledge segment of the course. The knowledge segment code is used when the course is to be offered by different departments either individually or together but having the same syllabus and course plan.

Course Number: MA 101 - This refers to a course in Mathematics with the course number 101.
Course Number: BE 102 - This refers to a course in Basic Engineering.

Course Number is a three digit number and the first digit refers to the Academic year in which the course is normally offered, i.e. 1, 2, 3, or 4 for the B. Tech. Programme of four year duration. Of the other two digits, the last digit identifies whether the course is offered normally in the odd (odd number), even (even number) or in both the semesters (zero). The middle number could be any digit.

MA 101 is a course in Mathematics offered in the first semester.
EE 344 is a course in Electrical Engineering offered in the sixth semester.
PH 110 is a course in Physics offered both the first and second semesters.
BE 102 is a course in Basic Engineering offered by one or many departments.

These course numbers are to be given in the curriculum and syllabi.

RU-2 Attendance

Attendance is marked for each course. While 75% attendance is mandatory for writing the end semester examination in that course, students are expected to have 100% attendance. However under unavoidable circumstances students are permitted to take leave. Leave is normally sanctioned for any approved activity taken up by students outside the college covering sports and other extracurricular activities. Leave is also permitted on medical grounds or on personal exigencies. Leave of absence for all these is limited to 25% of the academic contact hours for the course.

In case of long illness or major personal tragedies/contingencies the college Principal can relax the minimum attendance requirement to 60%, to write the end semester examination. This is permitted for one or more courses registered in the semester. Principal shall keep all records which led to his decision on attendance, for verification by the Academic Auditor. However this concession is applicable only to any two semesters during the entire programme. In case of prolonged illness, break of study is permitted as per RU-3.

RU-3 Break of Study

A student is permitted to have a break of study.

i) In case of accident or serious illness needing prolonged hospitalization and rest.
ii) In case the student has a bright idea and would like to initiate a start-up venture or develop a new product.
iii) In case of any personal reasons that need a break in study.

For break of study due to illness, student should submit all necessary medical reports together with the recommendation of the doctor treating him giving definite reasons for break of study and its duration. Before joining back the student should submit the fitness certificate from the doctor who treated him.

Students who want to initiate a start-up venture or a product development, have to submit a project report, clearly indicating the purpose, action plan, technical details, funding details and future plans to the college Principal. The Principal shall evaluate the proposal by constituting an expert team consisting of a technocrat and a bank executive and take an appropriate decision based on the team's recommendation. In the semester system followed by the University, break of study for an academic year is preferred over a semester break.

Students who want a break in study due to personal reasons shall convince the Principal on the genuine need for it by giving authentic evidence for the same.

RU-4 Leave of Absence

Students who want to take leave under RU2 have to submit a leave letter to the teacher conducting the course. This letter is to be forwarded to the Head of the Department with recommendation of the teacher indicating the total leave of absence the student has so far availed. Leave is to be sanctioned by the Head of the Department. For medical leave over three days, medical certificate indicating the need for leave is required. After any medical leave exceeding five

instruction days, on rejoining, the student has to produce the fitness certificate given by the doctor.

RU-5 Comprehensive Examination

This examination consists of two parts. Part one a written test and the other an oral one.

The written examination shall be objective type of 1 hour duration and shall have 50 marks and is to be conducted by the concerned department. Chairman of the oral examination board shall be a senior faculty in the department and the members include two other faculty members of the department and an external expert from another academic institute or an industry. Oral examination shall carry 50 marks. Comprehensive examination may be conducted any time during the 6^{th} semester with sufficient notice given to the students.

RU-6 Seminar

Students have to prepare a detailed report on the topic of the seminar and submit it to the teacher concerned. The seminar is to be of 20 minutes duration with another 5 minutes given for questions and answers. All students in the class have to attend the seminar without fail. Evaluation will be based on the report, seminar presentation as well as on the ability of the student to answer the questions put forward. Faculty member in charge of the seminar and another faculty member in the department nominated by the Head of the Department are the evaluators for the seminar. Distribution of marks for the seminar is as follows.

Marks for the report: 30%
Presentation: 40%
Ability to answer questions on the topic: 30%

RU-7 Ragging

Ragging of any nature is a criminal and non-bailable offence. Involvement in ragging shall lead to stringent punishment, including imprisonment as per the law of the land. A student, whose involvement in ragging is established, shall be summarily dismissed from the college. Each student of the Institute, along with his/her parent, is required to give an undertaking in this regard and the same is to be submitted at the time of registration.

Addendum:-

1. Calculation of SGPA/CGPA

Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) are calculated as follows.

SGPA = $\Sigma(C_i \times GP_i)/\Sigma C_i$ where C_i is the credit assigned for a course and GP_i is the grade point for that course. Summation is done for all courses registered by the student in the semester. Here the failed courses are also accounted.

CGPA = $\Sigma(C_i \times GP_i)/\Sigma C_i$ where C_i is the credit assigned for a course and GP_i is the grade point for that course. Summation is done for all courses registered by the student during all the semesters for which the CGPA is needed. Here the failed courses are also accounted. CGPA of all courses passed may also be given.

CGPA for the B. Tech programme is arrived at by considering all course credits that are needed for the degree and their respective grade points.

2. Student Activity Points

Activities that a student can engage in and the maximum quantum of points that can be earned from them are listed below.

i) National Level Activities

Code	Name of activity	Max. Activity Points	Minimum Duration
NA1	N S O	70	Two Semesters
NA2	N C C	70	Two Semesters
NA3	N S S	70	Two Semesters

ii) College Level Activities

CA1	Active Member/Office bearer of Professional Societies (Student Chapters)	30/40	Four Semesters
CA2	Elected Office bearer of Student forums	30	Two semesters
CA3	Member/Captain- College Athletic/ Games teams	20/30	Two Semesters
CA3	Executive Member of Student Clubs	20	Two Semesters
CA4	Volunteer for important College functions	20	Two Semesters
CA5	Committee member/ Organizer of Tech Fest/Cultural Fest/ Conference	20/30	Two Semesters

CA6	Placed within top three in Paper presentation/debate/ cultural competitions etc	30
CA7	Placed within top three in State level Sports/Games/	30

Additional 20 points are given for CA3/CA7 if the achievement is at the national level.

iii) Entrepreneurship

EA1	Any Creative Project execution	40
EA2	Awards for Projects	60
EA3	Initiation of Start-ups	60
EA4	Attracted Venture Capital	80
EA5	Filed a Patent	80
EA6	Completed Prototype Development	80

iv) Self Initiatives

SA1	Attend a National Conference	20
SA2	Attend an Int. National Conference	30
SA3	Published/ got an Award for a Technical paper.	30/40
SA4	Organiser of student level Technical Conf/Competition	30
SA5	Foreign language skills	50
SA6	Online courses taken& completed	50

Thiruvanthapuram
26-6-2015 **Registrar**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Engineering College Campus, Thiruvananthapuram

AMENDMENTS

OF THE

ORDINANCE

For

Bachelor of Technology B.Tech./B.Tech. (Hons)

Object of the Amendments:

The ordinance for B.Tech/B.Tech (Hons.) and M.Tech degree programs were framed considering the examinations and valuation system would be fully web based and assuming that the results could be published before the commencement of next semester classes. But as the examination system has been changed to the conventional system, it is impossible to publish the results before the commencement of next semester classes. Hence certain amendments are necessary. Also, the Controller of Examinations has suggested certain amendments in the ordinances regarding conduct of examination and malpractices. Further in the Academic Committee meeting also some amendments is suggested and the same is also incorporated.

In exercise of the Powers conferred under Section 44 and Section 45 of Act 17 of 2015, the following clauses are incorporated amending certain provisions of the Ordinance for B.Tech/ B.Tech(Hon) dated 26-6-2015; namely

AMEDMENT ORDINANCE No. 1

1. **Short Title and commencement:** This Ordinance is called Amendment to Ordinance for B.Tech/B.Tech(Hon) dated 26-6-2015 as Amendment Ordinance No.1 of 2016. This shall come into force with retrospective effect from 26-6-2015.

(i) In **Clause NO. 1(f)** , the following is also to be added.

For lateral entry to B.Tech/B.Tech (Hons.) programme only diploma holders shall be admitted subject to other eligible conditions prescribed by the Govt. of Kerala from time to time.

(ii) **Clause 2.(a)** under the heading **Examination** shall be amended as follows:-

Clause 2(a). At the end of the semester, end semester examination will be conducted in all lecture based courses offered in the semester and will normally be of three hours duration, unless otherwise specified. Supplementary examinations shall be conducted after declaration of results, for students who are eligible and have registered for them.

(iii) **Clause 7 (g)** under the heading **Course Registration and Enrolment shall be amended as follows:**

Clause 7 (g) : It is mandatory for students to register for the courses they want to attend in a semester. Students admitted freshly to the first semester, are advised to register for all courses listed for the semester. However they do not have to enroll for the semester. All other students are required to register and enroll for the courses they desire to take in the semester.

(iv) **Clause 7(h)** under the heading "**Course completion and Earning of Credits**", the following condition to be added

For students admitted under lateral entry scheme the credits for the first and second semesters shall be given by credit transfer from the Diploma programme

(v) **Clause 7(j)** under the heading **" Summer Course**", the following condition to be added.

The summer courses shall be considered as independent course and students have to register for this course. This provision of summer courses may be extended to students who have got FE grade due to (i) shortage of attendance (ie. having attendance less than 75%) and (ii) shortage of internal evaluation marks (ie. having IA marks less than 45%) with the following conditions.

(i) The students shall have minimum 50% attendance in the specified course of the regular semester. They have to register for the summer course and obtain 75% attendance.

(ii) The students shall have a minimum 35% IA marks in the regular semester. During the summer course the student will get a chance to improve the IA marks by writing one IA make up test during the summer course. This will replace the lower of the two marks got in the regular semester. However the IA marks shall be limited to 50%.

(vi) Clause 7 (l)(b)(iii)

30 marks for final written test /quiz in the evaluation of laboratory /practical courses in 3 to 8 semesters shall be awarded by conducting one end semester internal practical examination.

(iv) Clause 7 (q) Grades and Grade Points is to be amended as follows instead of the UGC Grade Points:

Clause 7 (q) : Grade and Grade Points

Grades and Grade Points followed by the University is as follows.

Grades		Grade Point (GP)	% of Total Marks obtained in the course
O	(Outstanding)	10	90% and above
A^+	(Excellent)	9	85% and above but less than 90%
A	(Very Good)	8.5	80% and above but less than 85%
B^+	(Good)	8	70% and above but less than 80%
B	(Above Average)	7	60% and above but less than 70%
C	(Average)	6	50% and above but less than 60%
P	(Pass)	5	45% and above but less than 50%
F	(Fail)	0	Less than 45%
FE		0	Failed due to eligibility criteria
I			Course Incomplete

(v) **Clause 7 (t)** Under the heading **Revaluation and Grade Improvement** shall be amended as follows:-

Clause 7 (t): There is no provision for improving the grade. The students can apply for revaluation of the answer books of the end semester examination after the results are declared. The final mark awarded will be the best of the two marks. If the difference in marks obtained in revaluation and the original valuation is more than 15% of the maximum marks, it will be sent for third valuation. The final mark will then be the average of the closest of the two marks obtained in the three valuations to the advantage of the student or the mark obtained in the original valuation whichever is higher. The Controller of Examination shall examine such cases and conduct proper enquiry to see whether any of the examiners has inadvertently responsible for negligent valuation of answer script and recommend for suitable action.

(v) **Clause 7(v)** under the heading B.Tech Degree, the following is to be added.

The grade card and degree certificate of students admitted under lateral entry scheme will indicate so.

(vi) Clause 7(x) (Last paragraph) shall be amended as follows:

Clause 7(x) (Last Paragraph) : In case of malpractices in end semester examinations, the report given by the college DAC and the action taken by the Principal shall be intimated to the Controller of Examination of the University. The Controller of Examinations shall refer the case to the Examination Monitoring Committee. The Controller of Examination will consider the same as a Review.

Trivanathapuram. With the approval of the Executive Committee.

21-4-2016. By Order Registrar.

Note : To be placed in the University Gazette.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Engineering College Campus, Thiruvananthapuram

AMENDMENTS

OF THE

ORDINANCE

For

Bachelor of Technology B.Tech./B.Tech. (Hons)

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In exercise of the Powers conferred under Section 44 and Section 45 of Act 17 of 2015, the following amendments to clauses are incorporated amending certain provisions of the Ordinance for B.Tech/ B.Tech(Hon) dated 26-6-2015 and in the 1st amendment Ordinance dated 21-04-2016.

AMENDMENT ORDINANCE No. 2

1. **Short Title and commencement:** This Ordinance is called Amendment to Ordinance for B.Tech/B.Tech(Hon) dated 26-6-2015 and the 1st Amendment Ordinance as Amendment Ordinance No.2 of 2016. This shall come into force with immediate effect.

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(i) **Clause 2.(a)** under the heading **Examination** shall be amended as follows:-

Clause 2(a). At the end of the semester, end semester examination will be conducted in all lecture based courses offered in the semester and will normally be of three hours duration, unless otherwise specified. **Supplementary examinations shall be conducted during summer vacation after the even semester examination and before the commencement of the next odd semester, for students who are eligible and have registered for the same.**

(ii) **Clause 7 (g)** under the heading **Course Registration and Enrolment** shall be amended as follows:

Clause 7 (g) : It is mandatory for students to register for the courses they want to attend in a semester. Students admitted freshly to the first semester, are advised to register for all courses listed for the semester. However they do not have to enroll for the semester. All other students are required to register and enroll for the courses they desire to take in the coming semester. They have to enroll for these courses at the beginning of the new semester, based on the previous semester results. This allows them to make changes in the list of courses already registered for. Before enrolment, students should clear all dues including any fees to be paid and should not have any disciplinary issues pending. The dates for registration and enrolment will be given in the academic calendar. Any late registration or enrolment, allowed up to 7 working days from the stipulated date, will attract a late fee. A student can withdraw from a course or substitute one already registered by another on valid reasons with the approval of the faculty advisor. However this has to be done within seven working days from the commencement of the semester. **The maximum number of credits a student can register for in a semester is limited to 28 instead of the 26.**

(iii) **Clause 7(l)** under the heading **Academic Assessment/Evaluation** will be amended and incorporated as follows:

Academic Evaluation of Courses

University follows a continuous academic evaluation procedure. Academic evaluation procedure and corresponding weights are as follows:-

a). For theory courses: -Normally 1/3rd weightage for internal evaluation and 2/3rd for end semester examination.

For convenience, the maximum marks for internal evaluation and end semester examination for theory courses are fixed as 50 and 100 respectively unless otherwise specified through internal circulars for any particular examination.

(iv) **Clause 7(t)** under the heading **Revaluation and Grade Improvement** shall be amended and incorporated as follows:

There is no provision for improving the grades. The student can apply for revaluation of the end semester examination after the results are published. The answer scripts already valued by two examiners will not be revalued again.

(v) **Clause 7(u)** under the heading **Grade Cards** will be amended and incorporated as follows:

Students who have written the end semester examination will be given the grade cards for the registered courses, in every semester **by the University. On earning the required credits for the degree, the University will issue the final consolidated grade sheet for the B. Tech programme including CGPA.**

(vi) Amendments and incorporation under the Rules of the Ordinance adding additional clause:

RU: 8 Under the heading Courses to be offered to B. Tech. (Honours) will be added as an additional Rule under the Ordinance:

RU : 8 . To earn 12 additional credits, the student has to take at least four courses of which two should be from the M.Tech specialisation. MOOC courses(massive open online courses) of relevance offered by Institutions of repute are to be identified by the student in consultation with the faculty advisor and get it approved from the University regarding the credits to be allotted. Additionally, there is an option for the student to join the summer projects offered by IISc & IITs.

Thiruvananthapuram. With the approval of the Executive Committee.

1-11-2016 By Order Registrar.

Note : To be placed in the University Gazette.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Modified Curriculum for B.Tech Degree Semesters I and II 2016

APJ Abdul Kalam Technological University
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SEMESTER I

Slot	Course No.	Subject	L-T-P	Hours	Credits
A	MA101	Calculus	3-1-0	4	4
B **(1/2)**	PH100	Engineering Physics	3-1-0	4	4
	CY100	Engineering Chemistry	3-1-0	4	4
C **(1/2)**	BE100	Engineering Mechanics	3-1-0	4	4
	BE110	Engineering Graphics	1-1-3	5	3
D	BE101-0X	Introduction to _____ Engineering	2-1-0	3	3
E	BE103	Introduction to Sustainable Engineering	2-0-1	3	3
F **(1/4)**	CE100	Basics of Civil Engineering	2-1-0	3	3
	ME100	Basics of Mechanical Engineering	2-1-0	3	3
	EE100	Basics of Electrical Engineering	2-1-0	3	3
	EC100	Basics of Electronics Engineering	2-1-0	3	3
S **(1/2)**	PH110	Engineering Physics Lab	0-0-2	2	1
	CY110	Engineering Chemistry Lab	0-0-2	2	1
T **(2/4)**	CE110/ME110/ EE110/EC110/ CS110/CH110	Basic Engineering Workshops (CS110 for CS and related branches and CH110 for CH and related branches only)	0-0-2 + 0-0-2	2 2	1 1
U		U100 Language lab/CAD Practice/Bridge courses/Micro Projects etc	0-0-(2/3)	(2/3)	
				30	**24/23**
V		V100 Entrepreneurship/TBI/NCC/NSS/ Physical Edn. etc	0-0-2	2	Activity points

Notes:

1. Basic Engineering course of the parent branch included as Introduction to _____ Engineering. (3 credits)

List of Courses offered under BE 101-0X and Branches associated with each course

1. **BE101-01 Introduction to Civil Engineering**

   Civil Engineering

2. **BE101-02 Introduction to Mechanical Engineering Sciences**

   Aeronautical Engineering, Automobile Engineering, Food Technology, Industrial Engineering, Mechanical Engineering, Mechanical Engineering (Automobile), Mechanical Engineering (Production), Mechatronics, Metallurgy, Naval Architecture & Ship Building , Production Engineering.

3. **BE101-03 Introduction to Electrical Engineering**

   Electrical & Electronics Engineering.

4. **BE101-04 Introduction to Electronics Engineering**

   Applied Electronics & Instrumentation Engineering, Biomedical Engineering, Electronics & Biomedical Engineering, Electronics & Communication Engineering, Electronics & Instrumentation Engineering, Instrumentation & Control Engineering.

5. **BE101-05 Introduction to Computing and Problem Solving**

   Computer Science & Engineering, Information Technology.

6. **BE101-06 Introduction to Chemical Engineering**

   Biotechnology/ Biotechnology & Biochemical Engineering, Chemical Engineering,

2. Institutions can recommend **one of four** other Basic Engineering courses offered during this semester for every branch. However, the basic course selected should exclude the one corresponding to their branch of specialization. eg. Student who took Introduction to Civil Engineering should not take Basics of Civil Engineering; student who took Introduction to Electrical Engineering should not take Basics of Electrical Engineering

3. The six basic engineering workshops will be connected with the Introductory or Basics of Engineering courses offered. The students should attend **two workshops in Semester 1 and two in Semester 2.**

For example, students opting *Introduction to Civil Engineering* or Basics of Civil Engineering should attend the *Civil Engineering Workshop*, students opting *Introduction to Mechanical Engineering* or Basics of Mechanical Engineering should attend the *Mechanical Engineering Workshop*, students opting *Introduction to Chemical Engineering* should attend the *Chemical Engineering Workshop* and students opting *Introduction to Computing and Problem Solving* should attend the *Computer Science Workshop* etc. In addition, the students should attend one more workshop course in Semester 1, corresponding to the other Basic Engineering course they had been assigned by the institution. The workshop courses corresponding to both introductory and basic courses are same. However, the institutions may allot exercises or experiments listed in the syllabus based on the contents of corresponding theory course.

4. Engineering Physics and Engineering Chemistry shall be offered in both semesters. Institutions can advise students belonging to about 50% of the number of branches in the institution to opt for Engineering Physics in S1 and Engineering Chemistry in S2 and vice versa. Students opting for Engineering Physics in S1 should attend Engineering Physics Lab in S1 and students opting for Engineering Chemistry in S1 should opt for Engineering Chemistry Lab in S1.

5. Engineering Mechanics and Engineering Graphics shall be offered in both semesters. Institutions can advise students belonging to about 50% of number of branches in the institution to opt for Engineering Mechanics in Semester 1 and Engineering Graphics in Semester 2 and vice versa.

6. It may be noted that for items 4 and 5 above, all students belonging to a particular branch of study must be assigned the same course during one semester. For example, all students belonging to Electrical and Electronics Engineering in an institution may be assigned Engineering Physics and Engineering Physics lab, while all students in Electronics and Communication Engineering branch may be assigned Engineering Chemistry and Chemistry lab. Likewise, all students in Civil Engineering branch may be assigned Engineering Graphics, while all students in Mechanical Engineering branch may be allotted the Engineering Mechanics in Semester 1 and vice versa in Semester 2.

7. For **Course U**, the Institutions should conduct **diagnostic tests** to identify the training requirements of each student and advise them to attend the suitable programme. The students who excel in all diagnostic tests can be assigned **Micro projects** under the guidance of faculty members. The classes for which BE110 Engineering Graphics is offered under slot C may be divided into two batches and these batches shall attend CAD Practice lab & Language Lab in alternate weeks.

8. **Course V** is for earning activity points outside academic hours, the details are covered in rules and regulations of KTU.

SEMESTER II

Slot	Course No.	Subject	L-T-P	Hours	Credits
A	MA102	Differential Equations	3-1-0	4	4
B **(1/2)**	PH100	Engineering Physics	3-1-0	4	4
	CY100	Engineering Chemistry	3-1-0	4	4
C **(1/2)**	BE100	Engineering Mechanics	3-1-0	4	4
	BE110	Engineering Graphics	1-1-3	5	3
D	BE102	Design & Engineering	2-0-2	4	3
E, F **(2/4)**	CE 100	Basics of Civil Engineering	2-1-0	3	3
	ME 100	Basics of Mechanical Engineering	2-1-0	3	3
	EE 100	Basics of Electrical Engineering	2-1-0	3	3
	EC 100	Basics of Electronics Engineering	2-1-0	3	3
	CS 100	Computer Programming (Only for CSE & IT branches)	2-1-0	3	3
S **(1/2)**	PH110	Engineering Physics Lab	0-0-2	2	1
	CY110	Engineering Chemistry Lab	0-0-2	2	1
T **(2/4)**	CE110/ME110/ EE110/EC110	Basic Engineering Workshops	0-0-2	2	1
	CS 120	Computer Programming Lab (only for CSE & IT Branches)	+ 0-0-2	2	1
U		U100 Language lab / CAD Practice/ Bridge courses/ Micro Projects etc	0-0-(1/2)	(1/2)	
				30	**24/23**
V		V100 Entrepreneurship /TBI/NCC/NSS/ Physical Edn. etc	0-0-2	2	Activity points

Note 1: Institutions can assign **two of four** of Basics of Engineering courses not already taken by the student in the previous semester and the corresponding Workshop courses in Semester 2. CS 100 Basics of Computer Programming & CS120 Computer Programming Lab are mandatory for Computer Science & Engineering and Information Technology branches. Other branches are not allowed to opt these courses.

Note 2: **For Course U**, the classes for which BE110 Engineering Graphics is offered under slot C may be divided into two batches and these batches shall attend CAD Practice lab & Language Lab in alternate weeks.

Note: The Curriculum for Semesters I and II 2015 is slightly modified. The modifications are highlighted in red colour. The modified curriculum will not affect failed students of 2015 batch

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Curriculum

for

B.Tech Degree

Semesters III to VIII

2016

Mechanical Engineering

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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BRANCH:*Mechanical Engineering*

SEMESTER - 3

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
MA201	Linear Algebra & Complex Analysis	3-1-0	4	A
ME201	Mechanics of Solids	3-1-0	4	B
ME203	Mechanics of Fluids	3-1-0	4	C
ME205	Thermodynamics	3-1-0	4	D
ME210	Metallurgy & Materials Engineering	3-0-0	3	E
HS200/ HS210	Business Economics/Life Skills	3-0-0/ 2-0-2	3	F
ME231	Computer Aided Machine Drawing Lab	0-0-3	1	S
CE230	Material Testing Lab	0-0-3	1	T

Total Credits = 24 **Hours: 28/29** **Cumulative Credits= 71**

SEMESTER - 4

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
MA202	Probability Distributions, Transforms and Numerical Methods	3-1-0	4	A
ME202	Advanced Mechanics of Solids	3-1-0	4	B
ME204	Thermal Engineering	3-1-0	4	C
ME206	Fluid Machinery	2-1-0	3	D
ME220	Manufacturing Technology	3-0-0	3	E
HS210/ HS200	Life Skills/Business Economics	2-0-2/ 3-0-0	3	F
ME232	Thermal Engineering Lab	0-0-3	1	S
ME230	Fluid Mechanics & Machines Lab	0-0-3	1	T

Total Credits = 23 **Hours 28/27** **Cumulative Credits= 94**

BRANCH:*Mechanical Engineering*

SEMESTER - 5

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
ME301	Mechanics of Machinery	3-1-0	4	A
ME303	Machine Tools and Digital Manufacturing	3-0-0	3	B
ME305	Computer Programming & Numerical Methods	2-0-1	3	C
EE311	Electrical Drives &Control for Automation	3-0-0	3	D
HS300	Principles of Management	3-0-0	3	E
	Elective 1	3-0-0	3	F
ME341	Design Project	0-1-2	2	S
EE335	Electrical and Electronics Lab	0-0-3	1	T
ME331	Manufacturing Technology Lab I	0-0-3	1	U

Total Credits = 23 **Hours: 28** **Cumulative Credits= 117**

Elective 1:-
1. ME361 Advanced Fluid Mechanics
2. ME363 Composite Materials and Mechanics
3. ME365 Advanced Metal Casting
4. ME367 Non-Destructive Testing
5. ME369 Tribology
6. ME371 Nuclear Engineering
7. ME373 Human Relations Management

BRANCH:*Mechanical Engineering*

SEMESTER - 6

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
ME302	Heat & Mass Transfer	3-1-0	4	A
ME304	Dynamics of Machinery	2-1-0	3	B
ME306	Advanced Manufacturing Technology	3-0-0	3	C
ME308	Computer Aided Design and Analysis	3-0-0	3	D
ME312	Metrology and Instrumentation	3-0-0	3	E
	Elective 2	3-0-0	3	F
ME332	Computer Aided Design and Analysis Lab	0-0-3	1	S
ME334	Manufacturing Technology Lab II	0-0-3	1	T
ME352	Comprehensive Exam	0-1-1	2	U

Total Credits = 23 **Hours: 27** **Cumulative Credits= 140**

Elective 2:-

1. ME362 Control System Engineering
2. ME364 Turbo Machinery
3. ME366 Advanced Metal Joining Technology
4. ME368 Marketing Management
5. ME372 Operations Research
6. ME374 Theory of Vibration
7. ME376 Maintenance Engineering

BRANCH:*Mechanical Engineering*

SEMESTER - 7

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
ME401	Design of Machine Elements I	3-1-0	4	A
ME403	Advanced Energy Engineering	3-0-0	3	B
ME405	Refrigeration and Air Conditioning	2-1-0	3	C
ME407	Mechatronics	3-0-0	3	D
ME409	Compressible Fluid Flow	2-1-0	3	E
	Elective 3	3-0-0	3	F
ME451	Seminar & Project Preliminary	0-1-4	2	S
ME431	Mechanical Engineering Lab	0-0-3	1	T

Total Credits = 22 **Hours: 27** **Cumulative Credits= 162**

Elective 3:-

1. ME461 Aerospace Engineering
2. ME463 Automobile Engineering
3. ME465 Industrial Hydraulics
4. IE306 Supply Chain and Logistics Management
5. ME467 Cryogenic Engineering
6. ME469 Finite Element Analysis
7. ME471 Optimization Techniques

BRANCH: *Mechanical Engineering*

SEMESTER - 8

Course Code	*Course Name*	*L-T-P*	*Credits*	*Exam Slot*
ME402	Design of Machine Elements II	3-0-0	3	A
ME404	Industrial Engineering	3-0-0	3	B
	Elective 4	3-0-0	3	C
	Elective 5 (Non Departmental)	3-0-0	3	D
ME492	Project		6	S

Total Credits = 18 **Hours: 30** **Cumulative Credits= 180**

Elective 4:-

1. ME462 Propulsion Engineering
2. ME464 Robotics and Automation
3. ME466 Computational Fluid Dynamics
4. ME468 Nanotechnology
5. ME472 Failure Analysis and Design
6. ME474 Micro and Nano Manufacturing
7. ME476 Material Handling & Facilities Planning

ELECTIVE 5 (NON DEPARTMENTAL ELECTIVE COURSES)

(Note:- If a student has studied or chosen the elective course given within the brackets then the corresponding ND elective cannot be chosen)

1. AO482 FLIGHT AGAIST GRAVITY
2. AE482 INDUSTRIAL INSTRUMENTATION
3. AE484 INSTRUMENTATION SYSTEM DESIGN
4. AU484 MICROPROCESSOR AND EMBEDDED SYSTEMS
5. AU486 NOISE, VIBRATION AND HARSHNESS
6. BM482 BIOMEDICAL INSTRUMENTATION
7. BM484 MEDICAL IMAGING & IMAGE PROCESSING TECHNIQUES
8. BT461 DESIGN OF BIOLOGICAL WASTEWATER SYSTEMS
9. BT362 SUSTAINABLE ENERGY PROCESSES
10. CH482 PROCESS UTILITIES AND PIPE LINE DESIGN
11. CH484 FUEL CELL TECHNOLOGY
12. CE482 ENVIRONMENTAL IMPACT ASSESSMENT
13. CE484 APPLIED EARTH SYSTEMS
14. CE486 GEO INFORMATICS FOR INFRASTRUCTURE MANAGEMENT
15. CE488 DISASTER MANAGEMENT
16. CE494 ENVIRONMENT HEALTH AND SAFETY
17. CS482 DATA STRUCTURES
18. CS484 COMPUTER GRAPHICS
19. CS486 OBJECT ORIENTED PROGRAMMING
20. CS488 C # AND .NET PROGRAMMING
21. EE484 CONTROL SYSTEMS (ME 362/ CONTROL SYSTEM ENGINEERING)
22. EE486 SOFT COMPUTING

23. EE488 INDUSTRIAL AUTOMATION (ME464/ ROBOTICS AND AUTOMATION)

24. EE494 INSTRUMENTATION SYSTEMS

25. EC482 BIOMEDICAL ENGINEERING

26. FT482 FOOD PROCESS ENGINEERING

27. FT484 FOOD STORAGE ENGINEERING

28. FT486 FOOD ADDITIVES AND FLAVOURING

29.IE482 FINANCIAL MANAGEMENT

30. IE484 INTRODUCTION TO BUSINESS ANALYTICS

31.IE486 DESIGN AND ANALYSIS OF EXPERIMENTS

32. IE488 TOTAL QUALITY MANAGEMENT

33.IC482 BIOMEDICAL SIGNAL PROCESSING

34. IT482 INFORMATION STORAGE MANAGEMENT

35. MA482 APPLIED LINEAR ALGEBRA

36. MA484 OPERATIONS RESEARCH (ME 372/ OPERATIONS RESEARCH)

37. MA486 ADVANCED NUMERICAL COMPUTATIONS

38. MA488 CRYPTOGRAPHY

39.MP482 PRODUCT DEVELOPMENT AND DESIGN

40. MP469 INDUSTRIAL PSYCHOLOGY & ORGANIZATIONAL BEHAVIOUR

41. MP484 PROJECT MANAGEMENT

42. MT482 INDUSTRIAL SAFETY

43. FS482 RESPONSIBLE ENGINEERING

44. SB482 DREDGERS AND HARBOUR CRAFTS

45. HS482 PROFESSIONAL ETHICS

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B. Tech. Syllabus

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Modified Syllabus for I & II Semester B. Tech. Degree

2016

APJ Abdul Kalam Technological University
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COURSE NO.	COURSE NAME	CREDITS	YEAR OF INTRODUCTION
MA 101	CALCULUS	4	2016

Course Objectives

In this course the students are introduced to some basic tools in Mathematics which are useful in modelling and analysing physical phenomena involving continuous changes of variables or parameters. The differential and integral calculus of functions of one or more variables and of vector functions taught in this course have applications across all branches of engineering. This course will also provide basic training in plotting and visualising graphs of functions and intuitively understanding their properties using appropriate software packages.

Syllabus

Single Variable Calculus and Infinite series, Functions of more than one variable, Partial derivatives and its applications, Calculus of vector valued functions, Multiple Integrals.

Expected outcome

At the end of the course the student will be able to (i) check convergence of infinite series (ii) find maxima and minima of functions two variables (iii) find area and volume using multiple integrals (iv) apply calculus of vector valued functions in physical applications and (v) visualize graphs and surfaces using software or otherwise.

Text Books

(1)Anton, Bivens, Davis: Calculus, John Wiley and Sons, 10^{th}ed

(2)Thomas Jr., G. B., Weir, M. D. and Hass, J. R., Thomas' Calculus, Pearson

References:

1. Sengar and Singh, Advanced Calculus, Cengage Learning, Ist Edition
2. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India edition, 10^{th}ed.
3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi.
4. N. P. Bali, Manish Goyal, Engineering Mathematics, Lakshmy Publications
5. D. W. Jordan, P Smith. Mathematical Techniques, Oxford University Press, 4th

Edition. 6. A C Srivastava, P K Srivasthava, Engineering Mathematics Vol 1. PHI Learning Private Limited, New Delhi.

	COURSE NO: MA101	L-T-P:3-1-0	
	COURSE NAME: CALCULUS	CREDITS:4	
MODULE	CONTENT	HRS	END SEM. MARK %
I	Single Variable Calculus and Infinite series (Book I –sec 9.3,9.5,9.6,9.8) Basic ideas of infinite series and convergence - .Geometric series- Harmonic series-Convergence tests-comparison, ratio, root tests (without proof). Alternating series- Leibnitz Test- Absolute convergence, Maclaurins series-Taylor series - radius of convergence. (For practice and submission as assignment only: Sketching, plotting and interpretation of hyperbolic functions using suitable software. Demonstration of convergence of series bysoftware packages)	9	15%
II	Partial derivatives and its applications(Book I –sec. 13.3 to 13.5 and 13.8) Partial derivatives–Partial derivatives of functions of more than two variables - higher order partial derivatives - differentiability, differentials and local linearity - The chain rule – Maxima and Minima of functions of two variables - extreme value theorem (without proof)-relative extrema .	5 4	15%

FIRST INTERNAL EXAM			
III	Calculus of vector valued functions(Book I-12.1,12.2,12.4&12.6,13.6 &13.7) Introduction to vector valued functions- parametric curves in 3-space Limits and continuity – derivatives - tangent lines – derivative of dot and cross product- definite integrals of vector valued functions- unit tangent-normal- velocity-acceleration and speed–Normal and tangential components of acceleration. Directional derivatives and gradients-tangent planes and normal vectors (For practice and submission as assignment only: Graphing parametric curves and surfaces using software packages)	3 3 3	15%
IV	Multiple integrals (Book I-sec. 14.1, 14.2, 14.3, 14.5) Double integrals- Evaluation of double integrals – Double integrals in non-rectangular coordinates- reversing the order of integration- Area calculated as a double integral- Triple integrals(Cartesian co ordinates only)- volume calculated as a triple integral- (applications of results only)	4 2 2 2	15%
SECOND INTERNAL EXAM			
	Topics in vector calculus (Book I-15.1, 15.2, 15.3) Vector and scalar fields- Gradient fields –	2	

V	conservative fields and potential functions – divergence and curl - the operator - the Laplacian ∇^2 , Line integrals - work as a line integral- independence of path-conservative vector field – (For practice and submission as assignment only: graphical representation of vector fields using software packages)	2 2 2 2	20%
VI	Topics in vector calculus (continued) (Book I sec., 15.4, 15.5, 15.7, 15.8) Green's Theorem (without proof- only for simply connected region in plane), surface integrals – Divergence Theorem (without proof for evaluating surface integrals) , Stokes' Theorem (without proof for evaluating line integrals) (All the above theorems are to be taught in regions in the rectangular co ordinate system only)	2 2 3 3	20%
END SEMESTER EXAM			

Open source software packages such as gnuplot, maxima, scilab ,geogebra or R may be used as appropriate for practice and assignment problems.

TUTORIALS: Tutorials can be ideally conducted by dividing each class in to three groups. Prepare necessary materials from each module that are to be taught using computer. Use it uniformly to every class.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
PH100	ENGINEERING PHYSICS	3-1-0-4	2016

Course Objectives

Most of the engineering disciplines are rooted in Physics. In fact a good engineer is more or less an applied physicist. This course is designed to provide a bridge to the world of technology from the basics of science and to equip the students with skills in scientific inquiry, problem solving, and laboratory techniques.

Syllabus

Harmonic Oscillations: Damped and Forced Harmonic Oscillations. Waves: One Dimensional and Three Dimensional waves, Interference: Interference in thin films (Reflected system) Diffraction: Fraunhofer and Fresnel Diffraction, Grating, Polarization of Light: Double refraction, production and detection of polarized light, Superconductivity: Properties and Applications. Quantum Mechanics: Schrodinger Equations- Formulation and Solution, Operators, Applications. Statistical Mechanics: Microstates and macro states Maxwell - Boltzmann, Bose-Einstein and Fermi Dirac statistics. Fermi level and its significance. Acoustics: Intensity of sound, Reverberation and design concepts, Ultrasonics: Production, Detection and Applications, NDT methods, Lasers: Properties, Working Principles, Practical Lasers. Photonics: Basics of Solid State lighting, Photo detectors, Solar Cells, Fiber Optics.

Expected outcome

Familiarity with the principles of Physics and its significance in engineering systems and technological advances.

References:

- Aruldhas, G., Engineering Physics, PHI Ltd.
- Beiser, A., Concepts of Modern Physics, McGraw Hill India Ltd.
- Bhattacharya and Tandon, Engineering Physics , Oxford India
- Brijlal and Subramanyam, A Text Book of Optics, S. Chand & Co.
- Dominic and Nahari, A Text Book of Engineering Physics, Owl Books Publishers
- Hecht, E., Optics, Pearson Education
- Mehta, N., Applied Physics for Engineers, PHI Ltd
- Palais, J. C., Fiber Optic Communications, Pearson Education
- Pandey, B. K. and Chathurvedi, S., Engineering Physics, Cengage Learning
- Philip, J., A Text Book of Engineering Physics, Educational Publishers
- Premlet, B., Engineering Physics, Mc GrawHill India Ltd
- Sarin, A. and Rewal, A., Engineering Physics, Wiley India Pvt Ltd
- Sears and Zemansky, University Physics , Pearson
- Vasudeva, A. S., A Text Book of Engineering Physics, S. Chand & Co

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Web:

www.physics.org

www.howstuffworks.com

www.physics.about.com

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Harmonic Oscillations: Differential equation of damped harmonic oscillation, forced harmonic oscillation and their solutions- Resonance, Q factor, Sharpness of resonance- LCR circuit as an electrical analogue of Mechanical Oscillator (Qualitative)	5	15%
	Waves: One dimensional wave - differential equation and solution. Three dimensional waves - Differential equation & its solution. (No derivation) Transverse vibrations of a stretched string.	4	
II	Interference: Coherence. Interference in thin films and wedge shaped films (Reflected system) Newton's rings-measurement of wavelength and refractive index of liquid Interference filters. Antireflection coating.	5	15%
	Diffraction Fresnel and Fraunhofer diffraction. Fraunhofer diffraction at a single slit. Plane transmission grating. Grating equation - measurment of wavelength. Rayleigh's criterion for resolution of grating- Resolving power and dispersive power of grating.	4	
	FIRST INTERNAL EXAM		
III	Polarization of Light: Types of polarized light. Double refraction. Nicol Prism. Quarter wave plate and half wave plate. Production and detection of circularly and elliptically polarized light. Induced birefringence- Kerr Cell - Polaroid & applications.	4	15%
	Superconductivity: Superconducting phenomena. Meissner effect. Type-I and Type-II superconductors. BCS theory (qualitative). High temperature superconductors - Applications of superconductors.	5	
IV	Quantum Mechanics: Uncertainty principle and its applications- formulation of Time dependent and Time independent Schrödinger equations- physical meaning of wave function- Energy and momentum Operators-Eigen values and functions- One dimensional infinite square well potential .Quantum mechanical Tunnelling (Qualitative)	6	15%
	Statistical Mechanics: Macrostates and Microstates. Phase space. Basic postulates of Maxwell- Boltzmann, Bose-Einstein and Fermi Dirac	3	

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	statistics. Distribution equations in the three cases (no derivation). Fermi Level and its significance.		
SECOND INTERNAL EXAM			
V	Acoustics: Intensity of sound- Loudness-Absorption coefficient - Reverberation and reverberation time- Significance of reverberation time- Sabine's formula (No derivation) -Factors affecting acoustics of a building.	3	20%
	Ultrasonics: Production of ultrasonic waves - Magnetostriction effect and Piezoelectric effect - Magnetostriction oscillator and Piezoelectric oscillator - Detection of ultrasonics - Thermal and piezoelectric methods- Applications of ultrasonics - NDT and medical.	4	
VI	Laser: Properties of Lasers, absorption, spontaneous and stimulated emissions, Population inversion, Einstein's coefficients, Working principle of laser,Optial resonant cavity. Ruby Laser, Helium-Neon Laser, Semiconductor Laser (qualitative). Applications of laser, holography (Recording and reconstruction)	5	20%
	Photonics: Basics of solid state lighting - LED – Photodetectors - photo voltaic cell, junction & avalanche photo diodes, photo transistors, thermal detectors, Solar cells- I-V characteristics - Optic fibre-Principle of propagation-numerical aperture-optic communication system (block diagram) - Industrial, medical and technological applications of optical fibre. Fibre optic sensors - Basics of Intensity modulated and phase modulated sensors.	5	
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
CY100	ENGINEERING CHEMISTRY	3-1-0-4	2016

Course Objectives

To enable the students to acquire knowledge in the concepts of chemistry for engineering applications and to familiarize the students with different application oriented topics like new generation engineering materials, storage devices, different instrumental methods etc. And to develop abilities and skills that are relevant to the study and practice of chemistry.

Syllabus

Spectroscopy - Principles and Applications, Electrochemistry - Electrodes, Electrochemical series and applications, Nernst Equation, Potentiometric titration and application, Cells, Instrumental Methods- Thermal Analysis, Chromatography; Conductivity, Chemistry of Engineering Materials, Copolymers, Conducting Polymers, Advanced Polymers, Nano materials, Fuels and Calorific value; Lubricants and their properties, Water Technology - Hardness, Water softening methods, Sewage water Treatment.

Expected outcome

The student will be able to apply the knowledge of chemistry and will be equipped to take up chemistry related topics as part of their project works during higher semester of the course.

References Books:

- Ahad, J., Engineering Chemistry, Jai Publications
- Dara, S. S., Engineering Chemistry, S Chand Publishers
- Fernandez, A., Engineering Chemistry, Owl Book Publishers, ISBN 9788192863382
- Jain and Jain, Engineering Chemistry, Dhanpat Rai Publishers
- Kaurav, Engineering Chemistry with Laboratory Experiments. PHI, ISBN 9788120341746
- Manjooran K. S., Modern Engineering Chemistry, Kannatheri Publication
- Seymour, R. B., Introduction to Polymer Chemistry, McGraw Hill
- Rath, P., Engineering Chemistry, Cengage Learning, ISBN 9788131526699
- Wiley India, Engineering Chemistry, ISBN 9788126543205

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Spectroscopy: Introduction, Beer Lamberts Law (no derivations)(Numericals)	1	15%
	UV-visible spectroscopy - Principle, Instrumentation and applications	2	
	IR spectroscopy - Principle and applications (Numaericals)	2	
	^{1}H NMR spectroscopy - Principle, chemical shift - spin - spin splitting and applications including MRI(brief), Spectral Problems	4	
II	Electrochemistry: Different types of electrodes (general) – SHE, Calomel electrode, Glass electrode and determination of E^{0} using SHE & Calomel	2	15%

	electrode		
	Electrochemical series and its applications.(Numericals)	1	
	Nernst equation - Derivation, application & numericals	2	
	Potentiometric titration - Acid-base and redox titration	2	
	Lithium ion cell and Fuel cell.	1	
FIRST INTERNAL EXAM			
III	Instrumental Methods: Thermal analysis - Principle, instrumentation and applications of TGA and DTA.	3	15%
	Chromatographic methods - Basic principles, column, TLC. Instrumentation and principles of GC and HPLC.	4	
	Conductivity - Measurement of conductivity	1	
IV	Chemistry of Engineering Materials: Copolymers - BS, ABS - Structure and Properties.	1	15%
	Conducting Polymers - Polyaniline, Polypyrrole - Preparation, Structure and Properties.	2	
	OLED – An introduction	1	
	Advanced Polymers – Kevlar, Polybutadiene rubber and silicone rubber: Preparation, Structure and Properties.	2	
	Nanomaterials – Definition, Classification, chemical methods of preparation - hydrolysis and reduction	2	
	Properties and Applications – Carbon Nano Tubes and fullerenes.	1	
SECOND INTERNAL EXAM			
V	Fuels and Lubricants: Fuels - Calorific Value, HCV and LCV - Determination of calorific value of a solid and liquid fuel by Bomb calorimeter - Dulongs formula and Numericals.	3	20%
	Liquid fuel - Petrol and Diesel - Octane number & Cetane number	1	
	Biodiesel - Natural gas.	2	
	Lubricant - Introduction, solid, semisolid and liquid lubricants.	1	
	Properties of lubricants - Viscosity Index, Flash point, Fire point, Cloud point, Pour point and Aniline point.	2	
VI	Water Technology: Types of hardness, Units of hardness, Estimation of Hardness – EDTA method. Numericals based on the above	3	20%
	Water softening methods - Ion exchange process - Principle. Polymer ion exchange.	2	
	Reverse Osmosis - Disinfection method by chlorination and UV	1	
	Dissolved oxygen, BOD and COD.	2	
	Sewage water Treatment - Trickling Filter and UASB process.	1	
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
BE100	ENGINEERING MECHANICS	3-1-0-4	2016

Course Objectives

1. To apply the principles of mechanics to practical engineering problems.
2. To identify appropriate structural system for studying a given problem and isolate it from its environment.
3. To develop simple mathematical model for engineering problems and carry out static analysis.
4. To carry out kinematic and kinetic analyses for particles and systems of particles.

Syllabus

Statics: Fundamental concepts and laws of mechanics; Force systems; Principle of moments; Resultant of force and couple systems; Equilibrium of rigid body; Free body diagram; Equilibrium of a rigid body in three dimension; Support reactions; Properties of surfaces and solids - Centroid, Moment of inertia, Polar moment of inertia, Mass moment of inertia, Product of inertia and Principal moment of inertia; Theorems of Pappus – Guldinus; Friction; Principle of virtual work.

Dynamics: Rectangular and cylindrical coordinate system; Combined motion of rotation and translation; Newton's second law in rectilinear translation; D' Alembert's principle; Mechanical vibration; Simple harmonic motion; Spring-mass model.

Expected outcome

1. Students will be able to apply and demonstrate the concepts of mechanics to practical engineering problems.
2. Students will be able to determine the properties of planes and solids.
3. Students will be able to apply fundamental concepts of dynamics to practical problems.

Text Books:

- Shames, I. H., Engineering Mechanics - Statics and Dynamics, Pearson Prentice
- Timoshenko, S. & Young D. H., Engineering Mechanics, McGraw Hill

References Books:

- Babu, J., Engineering Mechanics, Pearson Prentice Hall
- Beer and Johnson, Vector Mechanics for Engineers - Statics and Dynamics, Tata McGraw Hill Publishing Company Limited
- Benjamin J., Engineering Mechanics, Pentex Book Publishers and Distributors
- Bhavikkatti, S. S., Engineering Mechanics, New Age International Publishers
- Hibbeler, R. C., Engineering Mechanics: Statics and Dynamics. Pearson Prentice Hall
- Kumar, K. L., Engineering Mechanics, Tata McGraw Hill Publishing Company Limited
- Merriam J. L. and Kraige L. G., Engineering Mechanics – Vol. I and II, John Wiley
- Rajasekaran S. and Sankarasubramanian, G., Engineering Mechanics, Vikas Publishing House Private Limited
- Tayal, A. K., Engineering Mechanics- Statics and Dynamics, Umesh Publications

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Statics: Fundamental concepts and laws of mechanics – Rigid body – Principle of transmissibility of forces	2	15%
	Coplanar force systems - Moment of a force – Principle of moments	2	
	Resultant of force and couple system	4	
	Equilibrium of rigid body – Free body diagram – Conditions of equilibrium in two dimensions – Two force and three force members.	3	
II	Types of supports – Problems involving point loads and uniformly distributed loads only.	5	15%
	Force systems in space – Degrees of freedom – Free body diagram – Equations of equilibrium – Simple resultant and Equilibrium problems.	4	
FIRST INTERNAL EXAM			
III	Properties of planar surfaces – Centroid and second moment of area (Derivations not required) - Parallel and perpendicular axis theorem – Centroid and Moment of Inertia of composite area.	3	15%
	Polar Moment of Inertia – Radius of gyration – Mass moment of inertia of cylinder and thin disc (No derivations required).	2	
	Product of inertia – Principal Moment of Inertia (conceptual level).	3	
	Theorems of Pappus and Guldinus.	1	
IV	Friction – Characteristics of dry friction – Problems involving friction of ladder, wedges and connected bodies.	6	15%
	Definition of work and virtual work – Principle of virtual work for a system of connection bodies – Problems on determinate beams only.	4	
SECOND INTERNAL EXAM			
V	Dynamics: Rectangular and Cylindrical co-ordinate system	1	20%
	Combined motion of rotation and translation – Concept of instantaneous centre – Motion of connecting rod of piston and crank of a reciprocating pump.	4	
	Rectilinear translation – Newton's second law – D'Alembert's Principle – Application to connected bodies (Problems on motion of lift only).	4	
VI	Mechanical vibrations – Free and forced vibration - Degree of freedom.	1	20%
	Simple harmonic motion – Spring-mass model – Period – Stiffness – Frequency – Simple numerical problems of single degree of freedom.	7	
END SEMESTER EXAM			

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Course No:	Course Name	L-T-P Credits	Year of Introduction
BE110	* ENGINEERING GRAPHICS	1-1-3-3	2016

*

As this course is practical oriented, the evaluation is different from other lecture based courses.

Points to note:

(1) End semester examination will be for 50 marks and of 3 hour duration.

(2) End semester exam will include all modules except Module IV.

(3) 100 marks are allotted for internal evaluation: first internal exam 40 marks, second internal exam 40 marks(CAD Lab Practice) and class exercises 20 marks.

(4) The first internal exam will be based on modules I and II and the second internal exam will be a practical exam in CAD based on Module IV alone. Second internal exam may be conducted at the end of the semester.

Course Objectives

To enable the student to effectively communicate basic designs through graphical representations as per standards.

Syllabus

Introduction to Engineering Graphics; Orthographic projections of lines and solids, Isometric projection, Freehand sketching, Introduction to CAD, Sections of solids, Development of surfaces, Perspective projection.

Expected outcome

Upon successful completion of this course, the student would have accomplished the following abilities and skills:

1. Fundamental Engineering Drawing Standards.
2. Dimensioning and preparation of neat drawings and drawing sheets.
3. Interpretation of engineering drawings
4. The features of CAD software

References Books:

Agrawal, B. and Agrawal, C. M., Engineering Drawing, Tata McGraw Hill Publishers

Anilkumar, K. N., Engineering Graphics, Adhyuth Narayan Publishers

Benjamin, J., Engineering Graphics, Pentex Publishers

Bhatt, N., D., Engineering Drawing, Charotar Publishing House Pvt Ltd.

Duff, J. M. and Ross, W. A., Engineering Design and Visualization, Cengage Learning, 2009

John, K. C., Engineering Graphics, Prentice Hall India Publishers

Kirstie Plantenberg, Engineering Graphics Essentials with AutoCAD 2016 Instruction, 4th Ed., SDC Publications

Kulkarni, D. M., Rastogi, A. P. and Sarkar, A. K., Engineering Graphics with AutoCAD, PHI 2009

Luzadder, W. J. and Duff, J. M., Fundamentals of Engineering Drawing, PHI 1993

Parthasarathy, N. S., and Murali, V., Engineering Drawing, Oxford University Press

Varghese, P. I., Engineering Graphics, V I P Publishers

Venugopal, K., Engineering Drawing & Graphics, New Age International Publishers

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	6 exercises Introduction to Engineering Graphics: Need for engineering drawing. Drawing instruments; BIS code of practice for general engineering drawing. Orthographic projections of points and lines:-Projections of points in different quadrants; Projections of straight lines inclined to one of the reference planes, straight lines inclined to both the planes; True length and inclination of lines with reference planes; Traces of lines.	14	20%

II	12 exercises Orthographic projections of solids:-Projections of simple solids* in simple positions, projections of solids with axis inclined to one of the reference planes and axis inclined to both the reference planes.	11	20%
FIRST INTERNAL EXAM			
III	12 exercises Isometric Projections:-Isometric projections and views of plane figures simple* and truncated simple* solids in simple position including sphere and hemisphere and their combinations. Freehand sketching: Freehand sketching of real objects, conversion of pictorial views into orthographic views and vice versa.	09	20%
IV	6 exercises Introduction to Computer Aided Drafting - familiarizing various coordinate systems and commands used in any standard drafting software - drawing of lines, circle, polygon, arc, ellipse, etc. Creating 2D drawings. Transformations: move, copy, rotate, scale, mirror, offset and array, trim, extend, fillet, chamfer. Dimensioning and text editing. Exercises on basic drafting principles, to create technical drawings. Creation of orthographic views of simple solids from pictorial views. Creation of isometric views of simple solids from orthographic views. Solid modelling and sectioning of solids, extraction of 2D drawings from solid models. (For internal examination only, not for University Examination).	15 (Additional hours are allotted in U slot for CAD practice)	Internal
SECOND INTERNAL EXAM (to be conducted only after finishing CAD Practice.)			
V	9 exercises Sections and developments of solids: - Sections of simple* solids in simple vertical positions with section plane inclined to one of the reference planes - True shapes of sections. Developments of surfaces of these solids.	12	20%

VI	6 exercises Intersection of surfaces: - Intersection of prism in prism and cylinder in cylinder - axis bisecting at right angles only. Perspective projections: - perspective projections of simple* solids.	09	20%
*Triangular, square, pentagonal and hexagonal prisms, pyramids, cones and cylinders.			
END SEMESTER EXAM			

Note:

1. First angle projection is to be followed.
2. CAD Practice is mandatory and shall be conducted in the time slot allotted for U slot in addition to 15 hours allotted for Module IV

Question Paper Pattern: Question Paper shall contain eight questions of 10 marks each out of which five questions are to be answered as explained below. The duration of examination is 3 hours.

Part A: Three questions from Modules I & II out of which two are to be answered.

Part B: Five questions from Modules III, V & VI out of which three are to be answered.

The questions are to be answered in A4 size booklet containing grid/plain sheets supplied by the university. Drawing sheets are not needed.

The evaluation of answers shall be based on the correctness of solution, judging the knowledge of student in concepts and principles of Engineering Graphics. Accuracy and neatness shall not be criteria for evaluation.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
BE101-01	INTRODUCTION TO CIVIL ENGINEERING	2-1-0-3	2016

Course Objectives

1. To provide the students an overview of the profession of Civil Engineering.
2. To give the students an illustration of the use and properties of various building materials and explain the building construction aspects.

Syllabus

Civil Engineering as a profession; General introduction to history of Civil Engineering; types and classification of buildings; setting out of a building; Building materials - Stones, Bricks, Tiles, Cement, Aggregate, Cement mortar, Timber, Steel; Building Construction - Stone Masonry, Brick Masonry, Floors and flooring, Roofs and roof coverings.

Expected outcome

Students will be able to explain the importance of Civil Engineering in the infrastructural development of the society.

1. They will be able to illustrate the types, uses and properties of various building materials.
2. Students will be able to explain the method of construction of different components of a building.

References Books:

- Chen, W. F. and Liew, J. Y. R., (Eds.), The Civil Engineering Handbook, Second Edition, CRC Press (Taylor and Francis)
- Dalal, K. R., Essentials of Civil Engineering, Charotar Publishing House
- Gopi, S., Basic Civil Engineering, Pearson Publishers
- Kandya, A. A., Elements of Civil Engineering, Charotar Publishing house
- Mamlouk, M. S. and Zaniewski, J. P., Materials for Civil and Construction Engineering, Pearson Publishers.
- McKay, W. B. and McKay, J. K., Building Construction Volumes 1 to 4, Pearson India Education Services
- Rangwala, S. C. and Dalal, K. B., Engineering Materials, Charotar Publishing house
- Rangwala, S. C. and Dalal, K. B., Building Construction, Charotar Publishing house

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	General introduction to Civil Engineering - History of Civil Engineering - Relevance of Civil Engineering in the overall infrastructural development of the country.	2	15%
	Types and classification of structures - buildings, towers, chimneys, bridges, dams, retaining walls, water tanks, silos, roads, railways,	3	

	runways and pipelines (Brief description only)		
	Definition and types of buildings as per National Building Code of India (brief description only).	1	
	Selection of site - Components of a building and their functions - Setting out of a building.	2	
II	Stones: Classification of stones - Qualities of good building stones - Quarrying - Dressing - Tests - Specifications - Uses of common building stones.	2	15%
	Bricks: Composition of good brick earth - Classification - Qualities of good bricks - Field and laboratory tests - Specifications.	2	
	Tiles: Classification - Manufacture - Properties - Tests - Specifications	3	
	FIRST INTERNAL EXAM		
III	Cement: Basic Ingredients – Manufacturing process - Grades - Properties - Tests - Specifications.	4	15%
	Aggregates: Fine and coarse aggregate - Properties - Uses - Tests.	3	
	Cement Mortar: Types and preparation.	1	
IV	Stone Masonry: Types - Details of Ashlar, Random Rubble, Coarse Rubble and Dry Rubble Masonry.	3	15%
	Brick Masonry: Types - Bond - Introduction to all types of bonds - English bond in detail (1, 1½ and 2 brick walls) - Comparison of stone and brick masonry.	4	
	SECOND INTERNAL EXAM		
V	Timber: Properties - Uses - Classification - Seasoning - Defects - Preservation - Tests; Hard board and Particle board - Manufacture and use.	3	20%
	Steel: Structural steel and steel as reinforcement - Types - Properties - Uses - Market forms.	3	
VI	Floors and Flooring materials: Different types and selection of floors and floor coverings.	3	20%
	Roofs and roof coverings: Different types of roofs - Suitability - Types and selection of roofing materials.	3	
	END SEMESTER EXAM		

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Course No:	Course Name	L-T-P Credits	Year of Introduction
BE101-02	INTRODUCTION TO MECHANICAL ENGINEERING SCIENCES	2-1-0-3	2016

Course Objectives

1. To introduce different disciplines of Mechanical Engineering
2. To kindle interest in Mechanical Engineering
3. To impart basic mechanical engineering principles

Syllabus

Thermodynamics & Power sources, Thermal Engineering, Refrigeration and Air Conditioning, Automobile & Aeronautical Engineering, Engineering Materials and manufacturing.

Expected Outcome

At the end of the course, the students will have exposed to the different areas of Mechanical Engineering; gained idea about nature, scope and applications of Mechanical Engineering principles.

References Books:

Dossat, R. J., Principles of Refrigeration, PHI

Heywood, J., Internal Combustion Engine Fundamentals, McGraw Hill Publishers

Holman, J. P., Thermodynamics, McGraw Hill Co.

Jain, K. K. and Asthana, R. B., Automobile Engineering, TTTI Bhopal

Jonathan Wickert, Introduction to Mechanical Engineering, Cengage Learning

Kalpakjian, S. and Schmid, S. R., Manufacturing Processes for Engineering Materials, Pearson education

Maines, R., Landmarks in Mechanical Engineering, ASME

Peng, W. W., Principles of Turbomachinery, John Wiley & Sons

Pita, E. G., Air Conditioning Principles & Systems, PHI.

Spalding, D. B. and Cole, E. H., Engineering Thermodynamics, ELBS & Edward Arnold (Pub) Ltd.

Stone, R. and Ball, T. K., Automotive Engineering Fundamentals, SAE International

Sutton, G. P. and Ross, D. M., Rocket Propulsion Elements, John Wiley & Sons

Von Karman, T., Aerodynamics: Selected Topics in the Light of Their Historical Development, Courier Corporation

Online course on Refrigeration & Air conditioning, IIT Kharagpur www.nptel.ac.in

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	**Thermodynamics**: Nature and scope of thermodynamics; Basic concepts ; Laws of thermodynamics- Discovery, Significance & Applications; Qualitative ideas on Entropy, Available energy, Irreversibility, Principle of increase of entropy & Carnot engine; Limitations of Thermodynamics; Sources of power; history of power production; power production in the future.	8	15%
II	**Thermal Engineering:** Historical development of steam engine, steam turbines, gas turbinesand hydraulic turbines; Principle of turbomachinery; History of IC engines; two stroke and four stroke engines-working, applications; Air compressors- types and uses; Principles of Rocket propulsion, chemical rockets, Indian space programme	8	15%
FIRST INTERNAL EXAM			
III	**Refrigeration & Air Conditioning:** History & scope of refrigeration; applications of refrigeration; Food preservation, refrigerated storage; applications in chemical and process industries; special applications; Air conditioning- Principles & systems; scope of air conditioning; Psychrometric properties of air; Human comfort; comfort standards.	7	15%
IV	**Automobile & Aeronautical Engineering**: Introduction to an Automobile; history of the automobile; Indian Automobiles; Types of automobiles; Major components and their functions; Manufacturers of motor vehicles in India; Fundamentals of aerodynamics; drag force and lift force; jet engines types and applications.	7	15%
SECOND INTERNAL EXAM			
V	**Engineering Materials:** Introduction and history of materials; Basic crystallography; metals, alloys, composites, ceramics, polymers; mechanical properties and testing of engineering materials.	5	20%
VI	**Manufacturing Engineering :**	7	20%

	Methods of manufacturing; casting, forging, rolling, extrusion; machining operations – turning, milling, drilling, grinding, shaping, planing; Joining operations – soldering, brazing & welding; Introduction to CNC machines(elementary idea only); examples of typical products manufactured by above methods.		

END SEMESTER EXAM

Question Paper Pattern:

Part A: Modules I and II – three questions of 15 marks each – out of which two questions are to be answered.

Part B: Modules III and IV – three questions of 15 marks each – out of which two questions are to be answered.

Part C: Modules V and VI – three questions of 20 marks each – out of which two questions are to be answered.

Each question can have maximum of four subdivisions (a,b,c,d).

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Course No.	Course Name	L-T-P Credits	Year of Introduction
BE101-03	INTRODUCTION TO ELECTRICAL ENGINEERING	2-1-0-3	2016

Course Objective

The objective of this course is to set a firm and solid foundation in Electrical Engineering with strong analytical skills and conceptual understanding of basic laws and analysis methods in electrical and magnetic circuits.

Syllabus

Fundamental Concepts of Circuit Elements and Circuit variables, Real and Ideal independent voltage and current sources, V-I relations; Basic Circuit Laws, Analysis of resistive circuits, Magnetic Circuits, Electromagnetic Induction; Alternating current fundamentals, Phasor Concepts, Complex representation, Phasor analysis of RL, RC, RLC circuit, admittances; Complex Power, Resonance in series and parallel circuits; Three-phase systems, analysis of balanced and unbalanced star and delta connected loads.

Expected outcome

The course will enable students to learn advanced topics in Electrical Engineering

References Books:

Bhattacharya, S. K., Basic Electrical & Electronics Engineering, Pearson

Bird, J., Electrical Circuit Theory and Technology, Routledge, Taylor & Francis Group

Edminister, J., Electric Circuits, Schaum's Outline Series, Tata McGraw Hill

Hayt, W. H., Kemmerly, J. E., and Durbin, S. M., Engineering Circuit Analysis, Tata McGraw Hill

Hughes, Electrical and Electronic Technology, Pearson Education

Parker and Smith, Problems in Electrical Engineering, CBS Publishers and Distributors

Sudhakar and Syam Mohan, Circuits and Networks Analysis and Synthesis, Tata McGraw Hill

Suresh Kumar, K. S, Electric Circuits and Networks, Pearson Education

Course Plan			
Module	Contents	Hours	Sem. Exam. Marks
I	Fundamental Concepts of Circuit Elements and Circuit variables: Electromotive force, potential and voltage. Resistors, Capacitors Inductors- terminal V-I relations	1	15%
	Electromagnetic Induction: Faraday's laws, Lenz's law, statically and dynamically induced EMF, self and mutual inductance, coupling coefficient-energy stored in inductance	2	
	Real and Ideal independent voltage and current sources, V-I relations. Passive sign convention	1	
	Numerical Problems (Module I)	2	
II	Basic Circuit Laws: Kirchhoff's current and voltage laws, analysis of resistive circuits-mesh analysis –super mesh analysis	2	15%
	Node analysis-super node analysis, star delta transformation	2	
	Numerical problems (Module II)	2	
FIRST INTERNAL EXAMINATION			
III	Magnetic Circuits: Magneto motive force, flux, reluctance, permeability -comparison of electric and magnetic circuits, analysis of series magnetic circuits	2	15%
	Parallel magnetic circuits, magnetic circuits with air-gaps.	2	
	Numerical problems (Module III)	2	
IV	Alternating current fundamentals:-Generation of Alternating voltages-waveforms, Frequency, Period, RMS and average values, peak factor and form factor of periodic waveforms (pure sinusoidal) and composite waveforms	3	15%

	Phasor Concepts, Complex representation (exponential, polar and rectangular forms) of sinusoidal voltages and currents phasor diagrams	2	
	Complex impedance - series and parallel impedances and admittances, Phasor analysis of RL, RC, RLC circuits	2	
	Numerical problems. (Module IV)	2	
SECOND INTERNAL EXAMINATION			
V	Complex Power : Concept of Power factor: active , reactive and apparent power	1	20%
	Resonance in series and parallel circuits	2	
	Energy, bandwidth and quality factor, variation of impedance and admittance in series and parallel resonant circuits	2	
	Numerical problems (Module V)	2	
VI	Three phase systems: Star and delta connections, three-phase three wire and three-phase four-wire systems	2	20%
	Analysis of balanced and unbalanced star and delta connected loads	2	
	Power in three-phase circuits. Active and Reactive power measurement by one, two, and three wattmeter methods	2	
	Numerical problems (Module VI)	2	
END SEMESTER EXAMINATION			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
BE101-04	INTRODUCTION TO ELECTRONICS ENGINEERING	2-1-0-3	2016

Course Objectives

1. To get basic idea about types, specification and common values of passive components
2. To familiarize the working and characteristics of diodes, transistors and MOSFETS
3. To understand working of diodes in circuits and in rectifiers
4. To familiarize some measuring instruments

Syllabus

Evolution and Impact of Electronics, Familiarization of Resistors, Capacitors, Inductors, Transformers and Electro mechanical components, Semiconductors, PN junction diode, Zener diode, LED, photo diode, Bipolar Junction Transistors: Structure, principle of operation, different configurations, load line and operating point, biasing and stabilization, Transistor as amplifier, switch, Junction Field Effect Transistors: Structure, principle of operation, characteristics MOSFET: Structure, principle of operation, characteristics, Principle of operation of Photo transistor, UJT, SCR, Diode circuits and power supplies: Series and parallel diode circuits, Half-wave & full wave rectifiers, capacitor filter, zener voltage regulator, Electronic Measurements and measuring Instruments: Performance parameters, Analog and digital multimeter, CRO, DSO, function generator, Testing of Electronic components.

Expected outcome

Student can identify the active and passive electronic components and can design and setup simple circuits using diodes and transistors. Voltage and currents can be measured and monitored using electronic measuring instruments

References Books:

- Bell, D. A., Electronic Devices and Circuits, Oxford University Press
- Boylested, R. L. and Nashelsky, L., Electronic Devices and Circuit Theory, Pearson Education
- Kal, S., Basic Electronics: Devices, Circuits and its Fundamentals, PHI Learning
- Millman, J., Halkias, C. and Parikhu, C. D., Integrated Electronics, Tata Mc Graw Hill
- Neaman, D. A., Electronic Circuits Analysis and Design, McGraw Hill
- Sedra, A. S. and Smith, K. C., Microelectronic Circuits, Oxford University Press

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Evolution of Electronics, Impact of Electronics in industry and in society.	1	15%
	Resistors, Capacitors: types, specifications. Standard values, marking, colour coding.	3	
	Inductors and Transformers: types, specifications, Principle of working.	2	

	Electro mechanical components: relays and contactors.	1	
II	Diodes: Intrinsic and extrinsic semiconductors, PN junction diode, barrier potential, V-I characteristics, Effect of temperature. Equivalent circuit of a diode. Piece wise linear model.	3	15%
	Specification parameters of diodes and numbering.	1	
	Zener diode, Varactor diodes, characteristics, working principle of LED, photo diode, solar cell.	3	
FIRST INTERNAL EXAM			
III	Bipolar Junction Transistors: Structure, typical doping, Principle of operation, concept of different configurations. Detailed study of input and output characteristics of common base and common emitter configuration, current gain, comparison of three configurations.	3	15%
	Concept of load line and operating point. Need for biasing and stabilization, voltage divider biasing, Transistor as amplifier, switch, RC coupled amplifier and frequency response	3	
	Specification parameters of transistors and type numbering	1	
IV	Junction Field Effect Transistors: Structure, principle of operation, characteristics, comparison with BJT.	2	15%
	MOSFET: Structure, principle of operation of Enhancement type MOSFET, Current voltage characteristics, Depletion-type MOSFET.	2	
	Principle of operation of Photo transistor, UJT, SCR.	3	
SECOND INTERNAL EXAM			
V	Diode circuits and power supplies: Series and parallel diode circuits, Clippers, Clampers, Voltage multipliers	3	20%
	Half-wave and full wave (including bridge) rectifiers, Derivation of V_{rms}, V_{dc}, ripple factor, peak inverse voltage, rectification efficiency in each case, capacitor filter, working and design of a simple zener voltage regulator. Block diagram description of a DC Power supply, Principle of SMPS	4	
VI	Electronic Measurements and measuring Instruments.	2	20%
	Generalized performance parameters of instruments: error, accuracy, sensitivity, precision and resolution. Principle and block diagram of analog and digital multimeter, Block diagram of CRO, Measurements using CRO, Lissajous patterns, Principle and block diagram of DSO, function generator.	4	
	Testing of Electronic components.	1	
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
BE101-05	INTRODUCTION TO COMPUTING AND PROBLEM SOLVING	2-1-0-3	2016

Course Objectives

1. To learn basics of digital computers
2. To develop problem solving skills
3. To learn programming and to solve problems using computers

Syllabus

Introduction to digital computer, Introduction to programming languages, Operating systems, Problem Solving strategies, Examples for algorithms and flow charts, Introduction to Python language, functions, parameters and arguments, Boolean Expressions, logical operators and control statements Strings, lists, tuples and dictionaries, operations, Files, introduction to objects, attributes and instances

Expected outcome

1. Ability to design algorithmic solution to problems.
2. Ability to convert algorithms to Python programs.
3. Ability to design modular Python programs using functions
4. Ability to design programs with Interactive Input and Output, utilizing arithmetic expression repetitions, decision making, arrays.
5. Ability to design programs using file Input and Output.
6. Ability to develop recursive solutions.

Text Books:

- Downey, A. et al., How to think like a Computer Scientist: Learning with Python, John Wiley, 2015
- Goel, A., Computer Fundamentals, Pearson Education
- Lambert K. A., Fundamentals of Python - First Programs, Cengage Learning India, 2015
- Rajaraman, V., Computer Basics and C Programming, Prentice-Hall India

References Books:

- Barry, P., Head First Python, , O' Reilly Publishers
- Dromy, R. G., How to solve it by Computer, Pearson India
- Guzdial, M. J., Introduction to Computing and Programming in Python, Pearson India
- Perkovic, L., Introduction to Computing Using Python, 2/e, John Wiley, 2015
- Sprankle , M., Problem Solving & Programming Concepts, Pearson India
- Venit, S. and Drake, E., Prelude to Programming: Concepts & Design, Pearson India
- Zelle, J., Python Programming: An Introduction to Computer Science, Franklin, Beedle & Associates Inc.

Web links:

- https://archive.org/details/MIT6.00SCS11
- https://www.coursera.org/course/pythonlearn

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Introduction to digital computer –** Von Neumann concept – A simple model of computer, acquisition of data, storage of data, processing of data, output of processed data. Details of functional units of a computer. Storage – primary storage and secondary storage. *(The discussion should focus more on the functionalities of the units and their interaction than on specific hardware details. However, concepts like memory cells and their addressability (need not be binary), registers, inter-connections (buses) have to introduced at an abstract level. For storage devices – primary and secondary –, various categories have to be introduced along with their distinguishing features. For I-O devices also, various categories are to be introduced. The Von Neumann concept should be effectively introduced. History computers need not be taught. However, students have to be encouraged to read the relevant sections of the text book. Chapters 1 – 4 of 'Goel' may be used to support teaching -learning.)* **Introduction to programming languages:-** types of programming languages - high level language , assembly language and machine language, System software - Operating systems – objectives of operating systems, compiler, assembler and interpreter. *(For all the above topics, focus should be more on the concepts, significance and objectives. Chapter 6 and 7 (up to 7.4) of 'Goel' may be used to support the teaching-learning process.)*	8	15%
II	**Problem Solving strategies –** Problem analysis – formal definition of problem – Solution – top- down design – breaking a problem into sub problems- overview of the solution to the sub problems by writing step by step procedure (algorithm) - representation of procedure by flowchart - Implementation of algorithms – use of procedures to achieve modularity. *(For this part the instructor has to initially use suitable analogies of real world problems to explain the concepts, before delving into computer-solvable problems.)* **Examples for algorithms and flow charts** - at least 10 problems (starting	8	15%

	with non-numerical examples, and numeric problems like factorial, largest among three numbers, largest among N, Fibonacci *etc.; to be introduced with progressive levels of difficulty*) must be discussed in detail. *(Class assignments and/or tutorials may be used to strengthen understanding of this part. Chapters 4 and 5 of the 'Rajaraman' may be used for the teaching-learning process.)*		
	FIRST INTERNAL EXAM		
III	**Introduction to *Python*** – variables, expressions and statements, evaluation of expressions, precedence, string operations *(Note:- the instructor can demonstrate simple programs to the students and encourage them to develop similar ones. In particular, before attempting programs containing functions, the students should be given enough support and time to develop python code containing long sequence of statements for the simple flowcharts developed earlier. This will strengthen the students' understanding of instruction sequencing. Chapters 1 and 2 of 'Downey' have to be covered. Chapter 1 & 2 of 'Lambert' can also be used.)* Control statements, Boolean expressions and logical operators, conditional and alternative executions *(Note: - Chapter 4 of 'Downey' up to Section 4.9 has to be covered. The instructor should demonstrate each of these concepts with real examples and encourage students to develop as many as possible. Chapter 3 of 'Lambert' can be used for detailed discussion and self-study)* Iteration - *while* statement and tables. *(Note: - Chapter 6 of 'Downey' has to be covered. Chapter 3 of 'Lambert' can be used for detailed discussion and self-study.)*	8	15%
IV	Functions, calling functions, type conversion and coercion, composition of functions, mathematical functions, user-defined functions, parameters and arguments. *(Note: - Chapter 3 of 'Downey' has to be covered. The instructor should demonstrate each aspect of the function with real examples and encourage students to develop their own. Chapter 6 (up to 6.3) of 'Lambert' can be used for detailed discussion and self-study.)*	6	15%
	SECOND INTERNAL EXAM		
V	Strings and lists – string traversal and comparison with examples. *(Note: - Chapter 7 of 'Downey' has to be covered. Section 4.1 of 'Lambert' can be used for detailed discussion and self-study.)* List operations with examples *(Note: - Chapter 8 of 'Downey' up to Section 8.6 has to be covered. Section 5.1 of 'Lambert' can be used for detailed discussion and self-study.)*; tuples and dictionaries – operations and examples *(Note: -*	6	20%

	Chapters 9 & 10 of the third text have to be covered. Section 5.4 of 'Lambert' can be used for detailed discussion and self-study.)		
VI	Files and exceptions - text files, directories *(Note: - Chapter 11 of 'Downey' has to be covered)* Introduction to classes and objects - attributes, instances *(Note: - Chapter 12 of 'Downey' up to Section 12.6 has to be covered)*		
	END SEMESTER EXAM		

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Course No.	Course Name	L-T-P-Credits	Year of Introduction
BE101-06	INTRODUCTION TO CHEMICAL ENGINEERING	2-1-0-3	2016

Course Objectives

1. To instil in students the interest, excitement, and urge to learn the subject of Chemical Engineering
2. To introduce the profession of Chemical Engineering
3. To introduce the purpose of learning important subjects in Chemical Engineering for meeting the requirement of various professional fields in Chemical Engineering.

Syllabus

Introduction to Chemical Engineering, profession, plant operation, Basic concepts of units and equations of state, Overview of unit operations and processes, Modes of heat transfer, chemical reactions, DCDA process, basic concepts of P&I diagram. Introduction to process instrumentation and control, Introduction to safety in chemical process industries, introduction to Environmental Engineering, Challenges of Chemical Engineer, Introduction to novel materials and their development.

Expected outcome

The student will demonstrate the ability to understand the basic concepts of Chemical Engineering

References Books:

- Badger and Banchero, Introduction to Chemical Engineering, McGraw Hill
- McCabe, W. L., Smith, J.C. and Harriott, P., Unit Operations in Chemical Engineering, McGraw Hill
- Pushpavanam, S., Introduction to Chemical Engineering, PHI Learning Pvt. Ltd.
- Smith, R., Chemical Process Design and Integration, Wiley

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Chemical Engineering: history of Chemical Engineering, role of Chemical Engineering– a broad overview; chemical industries in India; introduction to Chemical Engineering profession; introduction to chemical plant operation; process development and process design.	6	15%
II	Basic concepts: units and dimensions, systems of units, conversion and conversion factors of units, concept of mole, weight percent, mole percent, normality, molarity, molality, vapor pressure, partial pressure, concept of ideal gas and equations of state.	7	15%
	FIRST INTERNAL EXAM		
III	Overview of unit operations such as distillation, evaporation, absorption,	8	15%

	adsorption, extraction, crystallization, drying, leaching, size separation and size reduction. Overview of unit processes like saponification, polymerization, biodiesel formation and hydrogenation.		
IV	Modes of heat transfer-principles of conduction, convection and radiation, heat exchangers. Fluid flow- laminar and turbulent flow. Introduction to transportation of fluids. Classification of chemical reactions, order of reaction, rate equation, Arrhenius equation, conversion and yield, batch reactor, mixed reactor and plug flow reactor.	8	15%
SECOND INTERNAL EXAM			
V	Block diagram, process flow diagram for DCDA process for Sulphuric acid manufacture, basic concepts of P&I diagram. Introduction to process instrumentation and control: common methodologies of measurements, measuring instruments: thermocouple, venturimeter, U-tube manometer, elements of feedback control loop, introduction to control of a distillation column.	7	20%
VI	Introduction to safety in chemical process industries – basic concepts, Case study: Bhopal gas tragedy. Introduction to Environmental Engineering - basic concepts, Typical wastewater, air and solid waste management system.Case study: Effect of Aerial Spraying of Endosulfan on Residents of Kasargod, Kerala. Challenges of Chemical Engineer –need for sustainable alternatives for processes; products with environment friendly life-cycle. Introduction to novel materials and their development.	6	20%
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
BE103	INTRODUCTION TO SUSTAINABLE ENGINEERING	2-0-1-3	2016

Course Objectives

- To have an increased awareness among students on issues in areas of sustainability
- To understand the role of engineering and technology within sustainable development;
- To know the methods, tools, and incentives for sustainable product-service system development
- To establish a clear understanding of the role and impact of various aspects of engineering and engineering decisions on environmental, societal, and economic problems.

Syllabus

Sustainability- need and concept, challenges, Environment acts and protocols, Global, Regional and Local environmental issues, Natural resources and their pollution, Carbon credits, Zero waste concept ISO 14000, Life Cycle Analysis, Environmental Impact Assessment studies, Sustainable habitat, Green buildings, green materials, Energy, Conventional and renewable sources, Technology and sustainable development, Sustainable urbanization, Industrial Ecology.

Expected outcome

The student will be

- Able to understand the different types of environmental pollution problems and their sustainable solutions
- Able to work in the area of sustainability for research and education
- Having a broader perspective in thinking for sustainable practices by utilizing the engineering knowledge and principles gained from this course

Reference Books:

- Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
- Bradley. A.S; Adebayo,A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning
- Environment Impact Assessment Guidelines, Notification of Government of India, 2006
- Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998
- ECBC Code 2007, Bureau of Energy Efficiency, New Delhi Bureau of Energy Efficiency Publications-Rating System, TERI Publications - GRIHA Rating System
- Ni bin Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, McGraw-Hill Professional.
- Twidell, J. W. and Weir, A. D., Renewable Energy Resources, English Language Book Society (ELBS).

• Purohit, S. S., Green Technology - An approach for sustainable environment, Agrobios publication			
Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Sustainability - Introduction, Need and concept of sustainability, Social-environmental and economic sustainability concepts. Sustainable development, Nexus between Technology and Sustainable development, Challenges for Sustainable Development. Multilateral environmental agreements and Protocols - Clean Development Mechanism (CDM), Environmental legislations in India - Water Act, Air Act.	L4	15%
	Students may be assigned to do at least one project eg: a) Identifying/assessment of sustainability in your neighbourhood in education, housing, water resources, energy resources, food supplies, land use, environmental protection etc. b) Identify the threats for sustainability in any selected area and explore solutions for the same	P1	
II	Air Pollution, Effects of Air Pollution; Water pollution- sources, Sustainable wastewater treatment, Solid waste - sources, impacts of solid waste, Zero waste concept, 3 R concept. Global environmental issues- Resource degradation, Climate change, Global warming, Ozone layer depletion, Regional and Local Environmental Issues. Carbon credits and carbon trading, carbon foot print.	L6	15%
	Students may be assigned to do at least one project for eg: a) Assessing the pollution status of a small area b) Programmes for enhancing public environmental awareness c) Observe a pond nearby and think about the different measures that can be adopted for its conservation	P3	
FIRST INTERNAL EXAM			
III	Environmental management standards, ISO 14000 series, Life Cycle Analysis (LCA) - Scope and Goal, Bio-mimicking, Environment Impact Assessment (EIA) - Procedures of EIA in India.	L4	15%
	Students may be assigned to do at least one project eg: a) Conducting LCA of products (eg. Aluminium cans, PVC bottles, cars etc. or activities (Comparison of land filling and open burning) b) Conducting an EIA study of a small project (eg. Construction of a building)	P2	

IV	Basic concepts of sustainable habitat, Green buildings, green materials for building construction, material selection for sustainable design, green building certification, Methods for increasing energy efficiency of buildings. Sustainable cities, Sustainable transport.	L5	15%
	Students may be assigned to do at least one project eg: a) Consider the design aspects of a sustainable building for your campus b) Explore the different methods that can be adopted for maintaining a sustainable transport system in your city.	P2	
	SECOND INTERNAL EXAM		
V	Energy sources: Basic concepts-Conventional and non-conventional, solar energy, Fuel cells, Wind energy, Small hydro plants, bio-fuels, Energy derived from oceans, Geothermal energy.	L5	20%
	Students may be assigned to do at least one project eg: a) Find out the energy savings that can be achieved by the installation of a solar water heater b) Conduct a feasibility study for the installation of wind mills in Kerala	P2	
VI	Green Engineering, Sustainable Urbanisation, industrialisation and poverty reduction; Social and technological change, Industrial Processes: Material selection, Pollution Prevention, Industrial Ecology, Industrial symbiosis.	L5	20%
	Students may be assigned to do a group project eg: a) Collect details for instances of climate change in your locality b) Find out the carbon credits you can gain by using a sustainable transport system (travelling in a cycle or car pooling from college to home) c) Have a debate on the topics like: Industrial Ecology is a Boon or Bane for Industries?/Are we scaring the people on Climate Change unnecessarily?/Technology enables Development sustainable or the root cause of unsustainability?	P3	
	END SEMESTER EXAM		

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Course No.	Course Name	L-T-P-Credits	Year of Introduction
CE100	BASICS OF CIVIL ENGINEERING	2-1-0-3	2016

Course Objectives

1. To inculcate the essentials of Civil Engineering field to the students of all branches of Engineering.
2. To provide the students an illustration of the significance of the Civil Engineering Profession in satisfying societal needs.

Syllabus

General introduction to Civil Engineering - Introduction to types of buildings, Components of a residential building, Introduction to industrial buildings; Introduction to planning of residential buildings - Simple building plans; Introduction to the various building area terms; Setting out of a building; Surveying – Principles, Objectives, Horizontal measurements with tapes, Ranging; Levelling – Instruments, Reduction of levels; Modern surveying instruments; Building materials – Bricks, cement blocks, Cement, Cement mortar, Steel; Building construction – Foundations, Brick masonry, Roofs, Floors, Decorative finishes, Plastering, Paints and Painting; Basic infrastructure and services – Elevators, Escalators, Ramps, Air conditioning, Sound proofing, Towers, Chimneys, Water Tanks; Intelligent buildings.

Expected outcome

1. The students will be able to illustrate the fundamental aspects of Civil Engineering.
2. The students will be able to plan and set out a building.
3. Students will be able to explain the concepts of surveying for making horizontal and vertical measurements.
4. They will able to illustrate the uses of various building materials and explain the method of construction of different components of a building.
5. Students will be able to discuss about various services in a building.

References Books:

- Chudley, R., Construction Technology, Vol. I to IV, Longman Group, England
- Chudley, R. and Greeno, R., Building Construction Handbook, Addison Wesley, Longman Group, England
- Gopi, S., Basic Civil Engineering, Pearson Publishers
- Kandya, A. A., Elements of Civil Engineering, Charotar Publishing house
- Mamlouk, M. S., and Zaniewski, J. P., Materials for Civil and Construction Engineering, Pearson Publishers

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- McKay, W. B. and McKay, J. K., Building Construction Volumes 1 to 4, Pearson India Education Services
- Minu, S., Basic Civil Engineering, Karunya Publications
- Rangwala, S. C., Essentials of Civil Engineering, Charotar Publishing House
- Rangwala, S. C. and Dalal, K. B., Engineering Materials, Charotar Publishing house
- Rangwala, S. C. and Dalal, K. B., Building Construction, Charotar Publishing house

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Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	General Introduction to Civil Engineering - Various disciplines of Civil engineering, Relevance of Civil engineering in the overall infrastructural development of the country.	2	15%
	Introduction to types of buildings as per NBC; Selection of site for buildings.	2	
	Components of a residential building and their functions. Introduction to industrial buildings – office / factory / software development office / power house /electronic equipment service centre (any one related to the branch of study)	2	
	Students have to visit one such building and submit an assignment about the features of any one of the listed building related to their branch (Not included for exam).	1	
II	Building planning - Introduction to planning of residential buildings- Site plan, Orientation of a building, Open space requirements, Position of doors and windows, Size of rooms; Preparation of a scaled sketch of the plan of a single storeyed residential building in a given site plan.	4	15%
	Introduction to the various building area terms - Computation of plinth area / built up area, Floor area / carpet area - for a simple single storeyed building; Setting out of a building.	3	
FIRST INTERNAL EXAM			
III	Surveying - Principles and objectives of surveying;	1	15%
	Horizontal measurements – instruments used – tape, types of tapes; Ranging (direct ranging only) – instruments used for ranging.	3	
	Levelling - Definitions, principles, Instruments (brief discussion only) - Level field book - Reduction of levels - problems on levelling (height of collimation only).	3	
	Modern surveying instruments – Electronic distance meter, digital level, total station, GPS (Brief discussion only).	1	
IV	Building materials - Bricks, cement blocks - Properties and specifications.	2	15%

	Cement – OPC, properties, grades; other types of cement and its uses (in brief).	1	
	Cement mortar – constituents, preparation.	1	
	Concrete – PCC and RCC – grades.	1	
	Steel - Use of steel in building construction, types and market forms.	1	
	SECOND INTERNAL EXAM		
V	Building construction – Foundations; Bearing capacity of soil (definition only); Functions of foundations, Types - shallow and deep (sketches only).	2	
	Brick masonry – header and stretcher bond, English bonds – Elevation and plan (one brick thick walls only).	2	
	Roofs – functions, types, roofing materials (brief discussion only).	1	20%
	Floors – functions, types; flooring materials (brief discussion only).	1	
	Decorative finishes – Plastering – Purpose, procedure.	1	
	Paints and Painting – Purpose, types, preparation of surfaces for painting (brief discussion only).	2	
VI	Basic infrastructure and services - Elevators, escalators, ramps, air conditioning, sound proofing (Civil engineering aspects only)	2	20%
	Towers, Chimneys, Water tanks (brief discussion only).	1	
	Concept of intelligent buildings.	2	
	END SEMESTER EXAM		

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME100	BASICS OF MECHANICAL ENGINEERING	2-1-0-3	2016

Course Objectives

To expose the students to the thrust areas in Mechanical Engineering and their relevance by covering the fundamental concepts.

Syllabus

Thermodynamics, laws of thermodynamics, implications, cycles, energy conversion devices, steam and water machines, engines, turbo machines, refrigeration and air conditioning, power transmission devices in automobiles, latest trends, engineering materials and manufacturing processes, types of materials, alloys, shape forming methods, machine tools.

Expected outcome

The student will be able to understand the inter dependence of the thrust areas in Mechanical Engineering and their significance leading to the development of products, processes and systems.

References Books:

- Balachandran, Basic Mechanical Engineering, Owl Books
- Benjamin, J., Basic Mechanical Engineering, Pentex Books
- Clifford, M., Simmons, K. and Shipway, P., An Introduction to Mechanical Engineering Part I - CRC Press
- Crouse, Automobile Engineering, Tata Mc-Graw-Hill, New Delhi
- Gill, Smith and Zuirys, Fundamentals of IC Engines, Oxford and IBH publishing company Pvt. Ltd. New Delhi. Crouse, Automobile Engineering, Tata Mc-Graw-Hill, New Delhi.
- Nag, P. K., Basic and Applied Thermodynamics, Tata McGraw-Hill
- Pravin Kumar, Basic Mechanical Engineering
- Roy and Choudhary, Elements of Mechanical Engineering, Media Promoters & Publishers Pvt. Ltd., Mumbai.
- Sawhney, G. S., Fundamentals of Mechanical Engineering, PHI

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Thermodynamics: Laws of Thermodynamics, significance and Applications of thermodynamics, entropy, Ideal and real gas equations; Analysis of Carnot cycle, Otto cycle , Diesel cycle; Efficiency of these cycles.	7	15%
II	Energy conversion devices: Boilers, Steam turbines, Gas turbines; Working principle of two stroke and four stroke I.C.	7	15%

	Engines (SI and CI), Fuels, CRDI,MPFI,Hybrid Engines, Reciprocating pumps, centrifugal pumps and hydraulic turbines.(Elementary ideas only)		
	FIRST INTERNAL EXAM		
III	Refrigeration and Air Conditioning: Vapour compression refrigeration systems, Heat Pump, COP, Study of household refrigerator, Energy Efficiency Rating, Psychrometry, Psychrometric processes, window air conditioner, split air conditioner. Refrigerants and their impact on environment.	7	15%
IV	Automobiles and Power Transmission Devices, Different types of automobiles, types of power units in automobiles; major components and their functions (brief description only); Belts and belt drives; Chain drive; Rope drive; Gears and gear trains; friction clutch (cone and single plate), brakes (types and applications only).	7	15%
	SECOND INTERNAL EXAM		
V	Materials and manufacturing processes: Engineering materials, Classification, properties, Alloys and their Applications; Casting, Sheet metal forming, Sheet metal cutting, Forging, Rolling, Extrusion; Metal joining processes - soldering, brazing and welding; Powder metallurgy.(Elementary ideas only).	7	20%
VI	Machine Tools (Basic elements, Working principle and types of operations), Lathe, Drilling Machine, Shaper, planer, slotter, Milling Machine, Grinding machine; Introduction to CNC machines.	7	20%
	END SEMESTER EXAM		

Question Paper Pattern:

Part A: Modules I and II – three questions of 15 marks each – out of which two questions are to be answered.

Part B: Modules III and IV – three questions of 15 marks each – out of which two questions are to be answered.

Part C: Modules V and VI – three questions of 20 marks each – out of which two questions are to be answered.

Each question can have maximum of four subdivisions (a,b,c,d).

Course No.	Course Name	L-T-P Credits	Year of Introduction
EE100	BASICS OF ELECTRICAL ENGINEERING	2-1-0-3	2016

Course Objectives

To impart a basic knowledge in Electrical Engineering with an understanding of fundamental concepts.

Elementary concepts of electric circuits, Kirchhoff's laws, constant voltage and current sources, Matrix representation; Magnetic circuits, energy stored in magnetic circuits, Electromagnetic induction, Alternating current fundamentals; AC circuits, phasor representation of alternating quantities-rectangular, polar; Three phase systems, star and delta connection; Generation of power, power transmission and distribution; Transformers, Electric Machines-DC Machines, AC Motors.

The course will enable the students to gain preliminary knowledge in basic concepts of Electrical Engineering.

Bhattacharya, S. K., Basic Electrical & Electronics Engineering, Pearson

Bird, J., Electrical Circuit Theory and Technology, Routledge, Taylor & Francis Group

Del Toro,V.,Electrical Engineering Fundamentals, Prentice Hall of India.

Hayt, W. H., Kemmerly, J. E., and Durbin, S. M., Engineering Circuit Analysis, Tata McGraw Hill

Hughes, Electrical and Electronic Technology, Pearson Education

Mehta, V.K. and Mehta,R., Basic Electrical Engineering, S. Chand Publishing

Parker and Smith, Problems in Electrical Engineering, CBS Publishers and Distributors

Sudhakar and Syam Mohan, Circuits and Networks Analysis and Synthesis, Tata McGraw Hill

Suresh Kumar, K. S, Electric Circuits and Networks, Pearson Education

Course Plan

Module	Contents	Hours	Sem. Exam. Marks
I	Elementary concepts of electric circuits: Kirchhoff's laws, constant voltage and current sources-Problems	2	15%
	Formation of network equations by mesh current and node voltage methods-matrix representation-solution of network equations by matrix methods-problems	3	
	star-delta conversion(resistive networks only-derivation is not needed)-problems	1	

II	Magnetic Circuits: MMF, field strength, flux density, reluctance(definition only)-comparison between electric and magnetic circuits	2	15%
	Energy stored in magnetic circuits, magnetic circuits with air gap-Numerical problems on series magnetic circuits	2	
	Electromagnetic Induction: Faraday's laws, lenz's laws- statically induced and dynamically induced emfs-self inductance and mutual inductance, coefficient of coupling (derivation not needed)	2	
FIRST INTERNAL EXAMINATION			
III	Alternating Current fundamentals: Generation of alternating voltages-waveforms, frequency, period, average , RMS values and form factor of periodic waveform(pure sinusoidal)-Numerical Problems	2	15%
	AC Circuits: Phasor representation of alternating quantities-rectangular and polar representation	1	
	Analysis of simple AC circuits: concept of impedance, power and power factor in ac circuits-active, reactive and apparent power	2	
	solution of RL,RC and RLC series circuits-Numerical problems	2	
	Three phase systems: Generation of three phase voltages-advantages of three phase systems, star and delta connection (balanced only), relation between line and phase voltages, line and phase currents	3	
	three phase power measurement by two wattmeter method (derivation is not required) - Numerical problems	1	
IV	Generation of power: Block schematic representation of generating stations- hydroelectric power plants	1	15%
	Block schematic representation of Thermal and nuclear power plants	1	
	Renewable energy sources: solar, wind, tidal and geothermal (Block diagram and working only- No Problems)	1	
	Power transmission: Typical electrical power transmission scheme-need for high voltage transmission-(Derivation is not needed, No Problems)	1	
	Power Distribution: substation equipments, primary and secondary transmission and distribution systems- feeder, service	1	

	mains		
SECOND INTERNAL EXAMINATION			
V	Electric Machines: DC Generator and Motor-Construction-working principle- Back EMF	2	20%
	Types of motor-shunt, series, compound (short and long)-principle of operation of dc motor, applications-numerical problems (voltage -current relations only)	3	
	Transformer: Construction of single phase and three phase Transformers (core type only)-EMF equation and related numerical problems	2	
	Losses and efficiency of transformer for full load –numerical problems (no equivalent circuit)	2	
VI	AC Motors: Three phase induction motor-squirrel cage and slip ring induction motor	1	20%
	Working principle-synchronous speed, slip and related numerical problems. (no equivalent circuit)	1	
	AC Motors: Construction, principles of operation of single phase induction motor (no equivalent circuit)	1	
	Starting methods in single phase induction motors -split phase and capacitor start	2	
END SEMESTER EXAMINATION			

Course No:	Course Name	L-T-P Credits	Year of Introduction
EC100	BASICS OF ELECTRONICS ENGINEERING	2-1-0-3	2016

Course Objectives

1) To get basic idea about types, specification and common values of passive and active components.
2) To familiarize the working of diodes, transistors, MOSFETS and integrated circuits.
3) To understand the working of rectifiers, amplifiers and oscillators.
4) To get a basic idea about measuring instruments
5) To get a fundamental idea of basic communication systems and entertainment electronics

Syllabus

Evolution and Impact of Electronics in industries and in society, Familiarization of Resistors, Capacitors, Inductors, Transformers and Electro mechanical components, PN Junction diode: Structure, Principle of operation, Zener diode, Photo diode, LED, Solar cell, Bipolar Junction Transistors: Structure, Principle of operation, characteristics, Rectifiers and power supplies: Half wave and full wave rectifier, capacitor filter, zener voltage regulator, Amplifiers and Oscillators: common emitter amplifier, feedback, oscillators, RC phase shift oscillator, Analogue Integrated circuits: operational amplifier, inverting and non-inverting amplifier, Electronic Instrumentation: digital multimeter, digital storage oscilloscope, function generator, Radio communication: principle of AM & FM, Super heterodyne receiver, Satellite communication: geo-stationary satellite system, Mobile communication: cellular communications, Optical communication: system, principle of light transmission through fiber, Entertainment Electronics: Cable TV, CCTV system.

Expected Outcome

Student can identify the active and passive electronic components. Student can setup simple circuits using diodes and transistors. Student will get fundamental idea about basic communication systems and entertainment electronics.

Text Books:

Bell, D. A., Electronic Devices and Circuits, Oxford University Press
Tomasy, W., Advanced Electronic Communication system, PHI Publishers

References Books:

Boylested, R. L. and Nashelsky, L., Electronic Devices and Circuit Theory, Pearson Education
Frenzel, L. E., Principles of Electronic Communication Systems, Mc Graw Hill
Kennedy, G. and Davis, B., Electronic Communication Systems, Mc Graw Hill

Rajendra Prasad, Fundamentals of Electronic Engineering, Cengage Learning			
Course Plan			
Module	Contents	Hours	Sem. Marks
I	Evolution of Electronics, Impact of Electronics in industry and in society.	1	10%
	Resistors, Capacitors: types, specifications. Standard values, marking, colour coding.	3	
	Inductors and Transformers: types, specifications, Principle of working.	2	
	Electro mechanical components: relays and contactors.	1	
II	PN Junction diode: Intrinsic and extrinsic semiconductors, Principle of operation, V-I characteristics, principle of working of Zener diode, Photo diode, LED and Solar cell.	4	20%
	Bipolar Junction Transistors: PNP and NPN structures, Principle of operation, input and output characteristics of common emitter configuration (npn only).	3	
FIRST INTERNAL EXAM			
III	Rectifiers and power supplies: Block diagram description of a dc power supply ,Half wave and full wave (including bridge) rectifier, capacitor filter, working of simple zener voltage regulator.	4	15%
	Amplifiers and Oscillators: Circuit diagram and working of common emitter amplifier, Block diagram of Public Address system, concepts of feedback, working principles of oscillators, circuit diagram & working of RC phase shift oscillator.	4	
IV	Analogue Integrated circuits: Functional block diagram of operational amplifier, ideal operational amplifier, inverting and non-inverting Amplifier.	3	15%
	Digital ICs: Logic Gates.	1	
	Electronic Instrumentation: Principle and block diagram of digital multimeter, digital storage	2	

	oscilloscope, and function generator.		
SECOND INTERNAL EXAM			
V	Radio communication: principle of AM & FM, frequency bands used for various communication systems, block diagram of super heterodyne receiver.	3	20%
	Satellite communication: concept of geo-stationary Satellite system.	2	
VI	Mobile communication: basic principles of cellular communications, concepts of cells, frequency reuse.	2	20%
	Optical communication: block diagram of the optical communication system, principle of light transmission through fiber, advantages of optical communication systems.	2	
	Entertainment Electronics Technology: Basic principles and block diagram of cable TV, CCTV, DTH system.	2	
END SEMESTER EXAM			

Note: Analysis is not required in this course.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
MA102	DIFFERENTIAL EQUATIONS	3-1-0-4	2016

Course Objectives

This course introduces basic ideas of differential equations, both ordinary and partial, which are widely used in the modelling and analysis of a wide range of physical phenomena and has got applications across all branches of engineering. The course also introduces Fourier series which is used by engineers to represent and analyse periodic functions in terms of their frequency components.

Syllabus

Homogeneous linear ordinary differential equation, non-homogeneous linear ordinary differential equations, Fourier series, partial differential equation, one dimensional wave equation, one dimensional heat equation.

Expected Outcome

At the end of the course students will have acquired basic knowledge of differential equations and methods of solving them and their use in analysing typical mechanical or electrical systems. The included set of assignments will familiarise the students with the use of software packages for analysing systems modelled by differential equations.

TEXT BOOKS

Erwin Kreyszig: Advanced Engineering Mathematics, 10th ed. Wiley

A C Srivastava, P K Srivasthava, Engineering Mathematics Vol 2. PHI Learning Private Limited, New Delhi.

REFERENCES:

Simmons: Differential Equation with Applications and its historical Notes,2e McGrawHill Education India 2002

Datta, Mathematical Methods for Science and Engineering. CengageLearing,1st. ed

B. S. Grewal. Higher Engineering Mathematics, Khanna Publishers, New Delhi.

N. P. Bali, Manish Goyal. Engineering Mathematics, Lakshmy Publications

D. W. Jordan, P Smith. Mathematical Techniques, Oxford University Press, 4th Edition.

C. Henry Edwards, David. E. Penney. Differential Equations and Boundary Value Problems. Computing and Modelling, 3rd ed. Pearson

COURSE PLAN			
	COURSE NO: MA102	L-T-P:3-1-0	
	COURSE NAME: DIFFERENTIAL EQUATIONS	CREDITS:4	
MODULE	CONTENT	HRS	END SEM. EXAM MARKS (OUT OF 100)
I	HOMOGENEOUS DIFFERENTIAL EQUATIONS (Text Book 1 : Sections 1.7, 2.1, 2.2, 2.6, 3.2) Existence and uniqueness of solutions for initial value problems, Homogenous linear ODEs of second order. Homogenous linear ODEs with constant coefficients, Existence and Uniqueness of solutions Wronskian, Homogenous linear ODEs with constant Coefficients (Higher Order) (For practice and submission as assignment only: Modelling of free oscillations of a mass – spring system)	3 4	17
II	NON-HOMOGENEOUS LINEAR ORDINARY DIFFERENTIAL EQUATIONS (Text Book 2: Sections 1.2.7 to 1.2.14) The particular Integral (P.I.), Working rule for P.I. when g(x) is X^m , To find P.I. when g(x) = $e^{ax}.V_1(x)$, Working rule for P.I. when g(x) = x.V(x), Homogeneous Linear Equations, PI of Homogenous equations Legendre's Linear equations Method of variation of parameters for finding PIs (For practice and submission as assignments only: Modelling forced oscillations, resonance, electric circuits)	7 2 3	17
FIRST INTERNAL EXAM			
III	FOURIER SERIES (Text Book 2 - Sections 4.1,4.2,4.3,4.4) Periodic functions ,Orthogonally of Sine and Cosine functions (Statement only), Fourier series and Euler's formulas Fourier cosine series and Fourier sine series (Fourier series of even and Odd functions) Half range expansions (All results without proof)	3 3 3	17

	(For practice and submission as assignment only: Plots of partial sums of Fourier series and demonstrations of convergence using plotting software)		
IV	PARTIAL DIFFERENTIAL EQUATIONS (Text Book 2 : Sections : 5.1, 5.1.1, 5.1.2, 5.1.5, 5.2.6- 5.2.10) Introduction to partial differential equations , formation of PDE, Solutions of first order PDE(Linear only) Lagrange's Method Linear PDE with constant coefficients , Solutions of Linear Homogenous PDE with constant coefficients , Shorter method for finding PI when g(x,y)=f(ax+by), Method of finding PI when $g(x,y) = x^m y^n$, method of find PI when $g(x,y)= e^{ax+by} V(x,y)$	3 3 6	17
SECOND INTERNAL EXAM			
V	ONE DIMENSIONAL WAVE EQUATION (Text Book 2: Sections :6.1-- 6.4) Method of separation of variables The wave Equation Vibrations of a stretched string Solutions of one dimensional wave equation using method of separation of variables and problems	2 1 1 4	16
VI	ONE DIMENSIONAL HEAT EQUATION (Text Book 2: sections 6.7, 6.8 ,6.9, 6.9.1 ,6.9.2) The equation of Heat conduction One dimensional Heat transfer equation. Solutions of One Dimensional Heat transfer equation, A long insulated rod with ends at zero temperatures, A long insulated rod with ends at non zero temperatures	1 1 6	16
END SEMESTER EXAM			

TUTORIALS: Tutorials can be ideally conducted by dividing each class into three groups. Prepare necessary materials from each module that can be practiced using computer software. Use them uniformly in every class.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
BE102	DESIGN AND ENGINEERING	2-0-2-3	2016

Course Objectives

The purpose of this course is:-

1. To excite the student on creative design and its significance;
2. To make the student aware of the processes involved in design;
3. To make the student understand the interesting interaction of various segments of humanities, sciences and engineering in the evolution of a design;
4. To get an exposure as to how to engineer a design.

Syllabus

Design and its objectives; Role of science, engineering and technology in design; Engineering as a business proposition; Creative design and the Design Process; Design evaluation and communication of designs; Design for function and strength; Material selection and design detailing; Role of standards in design Engineering the design; Design for "X"; Product centered and user centered design; Aesthetics and ergonomics; Concepts of value engineering, concurrent engineering and reverse engineering in design; Culture based design; Modular design; Design optimization needs; User interface; Intelligent and autonomous products; Internet of things; Advanced products and human psychology; Life cycle design; Product and its environment; Design as a marketing tool; Products and IPR; Product liability.

Expected outcome

The student will be:-

- Able to appreciate the different elements involved in good designs and to apply them in practice when called for.
- Aware of the product oriented and user oriented aspects that make the design a success.
- Will be capable to think of innovative designs incorporating different segments of knowledge gained in the course;
- Students will have a broader perspective of design covering function, cost, environmental sensitivity, safety and other factors other than engineering analysis.

References Books:

- Balmer, R. T., Keat, W. D., Wise, G., and Kosky, P., Exploring Engineering, Third Edition: An Introduction to Engineering and Design - [Part 3 - Chapters 17 to 27], ISBN-13: 978-0124158917 ISBN-10: 0124158919
- Dym, C. L., Little, P. and Orwin, E. J., Engineering Design - A Project based introduction - Wiley, ISBN-978-1-118-32458-5
- Eastman, C. M. (Ed.), Design for X Concurrent engineering imperatives, 1996, XI, 489 p. ISBN 978-94-011-3985-4 Springer
- Haik, Y. And Shahin, M. T., Engineering Design Process, Cengage Learning, ISBN-13: 978-0-495-66816-9
- Pahl, G., Beitz, W., Feldhusen, J. and Grote, K. H., Engineering Design: A Systematic Approach, 3rd ed. 2007, XXI, 617p., ISBN 978-1-84628-319-2
- Dieter and Schmidt, Engineering Design, McGraw Hill Education(India) Edition 2013

- Voland, G., Engineering by Design, ISBN 978-93-325-3505-3, Pearson India

Web pages:

1. E-Book (Free download): http://opim.wharton.upenn.edu/~ulrich/designbook.html
2. http://www2.warwick.ac.uk/fac/sci/wmg/ftmsc/modules/modulelist/peuss/designforx/design_for_x_notes_section_5.pdf

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Design and its objectives; Design constraints, Design functions, Design means and Design from; Role of Science, Engineering and Technology in design; Engineering as a business proposition; Functional and Strength Designs. Design form, function and strength;	L2	15%
	How to initiate creative designs? Initiating the thinking process for designing a product of daily use. Need identification; Problem Statement; Market survey-customer requirements; Design attributes and objectives; Ideation; Brain storming approaches; arriving at solutions; Closing on to the Design needs.	L3	
	An Exercise in the process of design initiation. A simple problem is to be taken up to examine different solutions-Ceiling fan? Group Presentation and discussion.	P4	
II	Design process- Different stages in design and their significance; Defining the design space; Analogies and "thinking outside of the box"; Quality function deployment-meeting what the customer wants; Evaluation and choosing of a design.	L2	15%
	Design Communication; Realization of the concept into a configuration, drawing and model. Concept of "Complex is Simple". Design for function and strength. Design detailing- Material selection, Design visualisation- Solid modelling; Detailed 2D drawings; Tolerancing; Use of standard items in design; Research needs in design; Energy needs of the design, both in its realization and in the applications.	L3	
	An exercise in the detailed design of two products (Stapler/ door/clock)	P4	
FIRST INTERNAL EXAM			
III	Prototyping- rapid prototyping; testing and evaluation of design; Design modifications; Freezing the design; Cost analysis.	L2	15%
	Engineering the design – From prototype to product. Planning; Scheduling; Supply chains; inventory; handling;	L3	

	manufacturing/construction operations; storage; packaging; shipping; marketing; feed-back on design.		
	List out the standards organizations. Prepare a list of standard items used in any engineering specialization. Develop any design with over 50% standard items as parts.	P4	
IV	Design for "X"; covering quality, reliability, safety, manufacturing/construction, assembly, maintenance, logistics, handling; disassembly; recycling; re-engineering etc. List out the design requirements(x) for designing a rocket shell of 3 meter diameter and 8 meter length.	L4	15%
	Design mineral water bottles that could be packed compactly for transportation.	P4	
SECOND INTERNAL EXAM			
V	Product centred and user centred design. Product centred attributes and user centred attributes. Bringing the two closer. Example: Smart phone. Aesthetics and ergonomics.	L2	20%
	Value engineering, Concurrent engineering, Reverse engineering in design; Culture based design; Architectural designs; Motifs and cultural background; Tradition and design; Study the evolution of Wet grinders; Printed motifs; Role of colours in design.	L4	
	Make sharp corners and change them to smooth curves-check the acceptance. Examine the possibility of value addition for an existing product.	P6	
VI	Modular design; Design optimization; Intelligent and autonomous products; User interfaces; communication between products; autonomous products; internet of things; human psychology and the advanced products. Design as a marketing tool; Intellectual Property rights – Trade secret; patent; copy-right; trademarks; product liability.	L3	20%
	Group presentation of any such products covering all aspects that could make or mar it.	P6	
END SEMESTER EXAM			

Evaluation Scheme:

First internal exam – closed book exam – 25 marks

Second internal exam – open book exam – 25 marks

Assignment/projects – 50 marks (iv) End semester exam – open book exam – 50 marks (2 hours duration – conducted by the University)

First Test: Marks: 25 Closed Book;

Questions may cover:-

Topics covered in the lectures.

How to arrive at the design details for a specific need gap given.

Sketching the design of a product that is to meet the given user requirements.

Second Test: Marks: 25 Open Book:

Students are permitted to bring in class notes, own notes, text books and other books (Maximum 3/4 books) for the test. Access to internet and mobile phones is NOT permitted.

Assignments: Marks: 20 Two assignments are to be given (10 marks each). These assignments are to cover specific design/s, sketching of the design, and a short but well written write-up on the design.

Projects: Marks: 30 Two mini projects are to be assigned. One is to be a group project and the other an individual one. A group of 3 or 4 students can take up the group project. Each project is to be evaluated for 15 marks.

The Group Project is to be done in the practical hours given for the course. Projects including the group projects are to be evaluated based on individual presentations and answers to the questions raised. These presentations could be done during the practical hours.

Question Paper Pattern for End Semester Examination (Open Book)

Part A – Eight questions of each 5 marks, out of which six questions are to be answered.

Part B – Three questions of each 10 marks, out of which two questions are to be answered.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
PH110	ENGINEERING PHYSICS LAB	0-0-2-1	2016

Course Objectives

This course is designed (i) to impart practical knowledge about some of the phenomena they have studied in the Engineering Physics course and (ii) to develop the experimental skills of the students.

List of Exercises / Experiments (Minimum of 8 mandatory)

Basics

1. Study of application of Cathode Ray Oscilloscope (CRO) for Frequency and Amplitude measurements. Lissajeous figures (useful for different types of polarized light.)
2. Temperature measurement – Thermocouple
3. Measurement of strain using strain gauge and Wheatstones bridge.

Waves, Oscillations and Ultrasonics

4. Wave length and velocity measurement of ultrasonic waves in a liquid using ultrasonic diffractometer.
5. The LCR Circuit – Forced and damped harmonic oscillations.
6. Meldes string apparatus. Measurement of frequency in the transverse and longitudinal mode.

Interference

7. Wave length measurement of a monochromatic source of light using Newton's Rings method.
8. Determination of refractive index of a liquid using Newton's Rings apparatus.
9. Determination of diameter of a thin wire or thickness of a thin strip of paper using air wedge method.

Diffraction

10. To determine the slit or pinhole width.
11. To measure wavelength using a millimeter scale as a grating.
12. Determination the wavelength of He-Ne laser or any standard laser using diffraction grating.
13. To determine the wavelength of monochromatic light using grating.
14. Determination of dispersive power and resolving power of a plane transmission grating.

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Polarisation

15. Kerr Effect - To demonstrate the Kerr effect in nitrobenzene solution and to measure the light intensity as a function of voltage across the Kerr cell using photo detector.
16. To measure the light intensity of plane polarised light as a function of the analyzer position.
17. Laurent's Half Shade Polarimeter -To observe the rotation of the plane of polarization of monochromatic light by sugar solution and hence to determine the concentration of solution of optically active substance.

Laser & Photonics

18. To determine the speed of light in air using laser.
19. Calculate the numerical aperture and study the losses that occur in optical fiber cable.
20. Determination of the particle size of lycopodium powder.
21. I-V characteristics of solar cell
22. To measure Planck's constant using photo electric cell.
23. Measurement of wavelength of laser using grating.

Reference Books:

- Avadhanulu, M. N., Dani, A. A. and Pokley, P. M., Experiments in Engineering Physics, S. Chand & Co.
- Gupta, S. K., Engineering Physics Practicals, Krishna Prakashan Pvt. Ltd.
- Koser, A. A., Practical Engineering Physics, Nakoda Publishers and Printers India Ltd
- Rao, B. S. and Krishna, K. V., Engineering Physics Practicals, Laxmi Publications
- Sasikumar, P. R. Practical Physics, PHI.

Website:

- http://www.indosawedu.com

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Course No.	Course Name	L-T-P-Credits	Year of Introduction
CY 110	ENGINEERING CHEMISTRY LAB	0-0-2-1	2016

List of Exercises / Experiments (Minimum of 8 mandatory)

1. Estimation of Total Hardness – EDTA method.
2. Estimation of Iron in Iron ore.
3. Estimation of Copper in Brass.
4. Estimation of dissolved oxygen by Winklers method.
5. Estimation of chloride in water.
6. Preparation of Urea formaldehyde and Phenol-formaldehyde resin.
7. Determination of Flash point and Fire point of oil by Pensky Martin Apparatus.
8. Determination of wavelength of absorption maximum and colorimetric estimation of Fe^{3+} in solution.
9. Determination of molar absorptivity of a compound other than Fe^{3+}.
10. Analysis of IR spectra of any three organic compounds.
11. Analysis of ^{1}H NMR spectra of any three organic compounds.
12. Calibration of pH meter and determination of pH of a solution.
13. Verification of Nernst equation for electrochemical cell.
14. Potentiometric titrations: acid – base and redox titrations
15. Conductivity measurements of salt solutions.
16. Flame photometric estimation of Na+ to find out the salinity in sand.

Expected outcome

The student will be able to apply and demonstrate the theoretical concepts of Engineering Chemistry.

References:

- Practical Engineering Chemistry Lab Manual, Owl book publishers

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Course No.	Course Name	L-T-P-Credits	Year of Introduction
CE110	CIVIL ENGINEERING WORKSHOP	0-0-2-1	2016

List of Exercises / Experiments (Minimum of 8 mandatory)

(For Civil Engineering Branch)

Setting out of a building: The student should set out a building (single room only) as per the given building plan using tape only.

Setting out of a building: The student should set out a building (single room only) as per the given building plan using tape and cross staff.

Construct a wall of height 50 cm and wall thickness 1½ bricks using English bond (No mortar required) - corner portion – length of side walls 60 cm.

Construct a wall of height 50 cm and wall thickness 2 bricks using English bond (No mortar required) - corner portion – length of side walls 60 cm.

Compute the area and/or volume of various features of a building/structure such as door and window size, number of bricks required to construct a wall of a building, diameter of bars used in windows etc. – To create an awareness of measurements and units (use tape or other simple measuring instruments like vernier caliper, screw gauge etc.).

Testing of building materials: The student should do the compression testing of any three construction materials and compare the strength (brick, hollow block, laterite block, cement concrete cube, stone block, and so on).

Computation of Centre of gravity and Moment of inertia of a given rolled steel section by actual measurements.

Introduction to simple plumbing and sanitary fittings.

Home assignment 1: Preparation of a building model - The students in batches should prepare and submit a building model for a given plinth area in a given site plan constrained by a boundary wall. The minimum requirements of a residential building viz., drawing cum dining room, one bed room and a kitchen should be included. The concept of an energy efficient building should also be included in the model.

Home assignment 2: Report preparation -The student should collect the construction details of any one unique Civil Engineering structure, prepare and submit a detailed report with neat illustrations.

Home assignment 3: Report preparation - The students should collect samples of building materials, prepare and submit a detailed report including their market rates.

(For braches other than Civil Engineering)

Setting out of a building: The student should set out a building (single room only) as per the given building plan using tape only.

Setting out of a building: The student should set out a building (single room only) as per the

given building plan using tape and cross staff. Building area computation: The student should prepare a rough sketch of a given single storeyed building and by taking linear measurements compute plinth area and carpet area of the given building. Construct a wall of at least a height of 500mm and wall thickness 1brick using English bond (No mortar required) - corner portion – length of side walls at least 600mm. Compute the area and/or volume of various features of a building/structure such as door and window size, number of bricks required to construct a wall of a building, diameter of bars used in windows etc. – To create an awareness of measurements and units (use tape or other simple measuring instruments like vernier calipers, screw gauge etc.). Horizontal measurements: Find the area of an irregular polygon set out on the field. Vertical measurements: Find the level difference between any two points. Computation of Centre of gravity and Moment of inertia of a given rolled steel section by sketching and measurements. Home assignment 1: Preparation of a building model - The students in batches should prepare and submit a building model for a given plinth area in a given site plan constrained by a boundary wall. The minimum requirements of a residential building viz., drawing cum dining room, one bed room and a kitchen should be included. The concept of an energy efficient building should also be included in the model. Home assignment 2: Report preparation - The student should collect the construction details of an industrial building related to their branch of study, prepare and submit a detailed report with neat illustrations. Home assignment 3: Report preparation - The students should collect samples of building materials, prepare and submit a detailed report about their market rates.

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Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME110	MECHANICAL ENGINEERING WORKSHOP	0-0-2-1	2016

Course Objectives

Introduction to manufacturing processes and applications. Familiarization of various tools, measuring devices, practices and machines used in various workshop sections.

List of Exercises / Experiments (Minimum of 8 mandatory)

Sl. No.	Name of Shop floor	Exercises	No of sessions
1	General	Studies of mechanical tools, components and their applications: (a) Tools: screw drivers, spanners, Allen keys, cutting pliers etc. And accessories (b) Components: Bearings, seals, O-rings, circlips, keys etc.	1
2	Carpentry	Any one model from the following: 1. T-Lap joint 2. Cross lap joint 3. Dovetail joint 4. Mortise joint	2
3	Smithy	(a) Demonstrating the forgability of different materials (MS, Al, Alloy steel and Cast steel) in cold and hot states. (b) Observing the qualitative differences in the hardness of these materials (c) Determining the shape and dimensional variations of Al test specimen due to forging under different states by visual inspection and measurements	2
4	Foundry	Any one exercise from the following 1. Bench moulding 2. Floor moulding 3. Core making	2
5	Sheet metal	Any one exercise from the following Making 1. Cylindrical 2. Conical 3. Prismatic shaped jobs from sheet metal	2
6	Welding	Any one exercise from the following Making joints using Electric arc welding. Bead formation in horizontal, vertical and overhead positions	2
7	Fitting and Assembly	Filing exercise and any one of the following exercises Disassembling and reassembling of 1. Cylinder piston assembly 2. Tail stock assembly 3. Time piece/clock 4. Bicycle or any machine.	2
8	Machines	Demonstration and applications of Drilling machine, Grinding machine, Shaping machine, Milling machine and lathe	2

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Course No.	Course Name	L-T-P-Credits	Year of Introduction
EE110	ELECTRICAL ENGINEERING WORKSHOP	0-0-2-1	2016

Course Objectives

The objective of this course is to familiarize the students with commonly used components, accessories and measuring equipment in Electrical installations. The course also provides hands on experience in setting up of simple wiring circuits.

List of Exercises / Experiments (Minimum of 8 mandatory)

1. Identify different types of cables/wires and switches and their uses.
2. Identify different types of fuses & fuse carriers, MCB and ELCB, MCCB with ratings and usage.
3. Wiring of simple light circuit for controlling light/fan point (PVC conduit wiring).
4. Wiring of light/fan circuit using Two way switches (Staircase wiring)
5. Wiring of fluorescent lamps and light sockets (6 A)
6. Wiring of Power circuit for controlling power device (16A socket)
7. Godown wiring / Tunnel wiring
8. Wiring of power distribution arrangement using single phase MCB distribution board with ELCB, Main switch and Energy meter.
9. Measurement of voltage, current and power in single phase circuit using voltmeter, ammeter and wattmeter. Calculate the power factor of the circuit.
10. Wiring of backup power supply including inverter, battery and load for domestic installations.
11. Demonstration and measurement of power consumption of electric iron, mixer grinder, single phase pump, exhaust fan, etc.
12. Energy meter reading and tariff calculation

Expected outcome

1. Familiarity with supply arrangements and their limitations, knowledge of standard voltages and their tolerances, safety aspects of electrical systems and importance of protective measures in wiring systems.
2. Knowledge about the types of wires, cables and other accessories used in wiring. Creating awareness of energy conservation in electrical systems.
3. Students should be able to wire simple lighting circuits for domestic buildings, distinguish between light and power circuits.
4. To measure electrical circuit parameters and current, voltage and power in a circuit.
5. Familiarity with backup power supply in domestic installation.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
EC110	ELECTRONICS ENGINEERING WORKSHOP	0-0-2-1	2016

Course Objectives

This course gives the basic introduction of electronic hardware systems and provides hands-on training with familiarization, identification, testing, assembling, dismantling, fabrication and repairing such systems by making use of the various tools and instruments available in the Electronics Workshop.

List of Exercises / Experiments (Minimum of 8 mandatory)

1. Familiarization/Identification of electronic components with specification (Functionality, type, size, colour coding, package, symbol, cost etc. [Active, Passive, Electrical, Electronic, Electro-mechanical, Wires, Cables, Connectors, Fuses, Switches, Relays, Crystals, Displays, Fasteners, Heat sink etc.)
2. Drawing of electronic circuit diagrams using BIS/IEEE symbols and introduction to EDA tools, Interpret data sheets of discrete components and IC's, Estimation and costing.
3. Familiarization/Application of testing instruments and commonly used tools. [Multimeter, Function generator, Power supply, CRO etc.] [Soldering iron, De-soldering pump, Pliers, Cutters, Wire strippers, Screw drivers, Tweezers, Crimping tool, Hot air soldering and de-soldering station etc.]
4. Testing of electronic components [Resistor, Capacitor, Diode, Transistor, UJT and JFET using multimeter.]
5. Inter-connection methods and soldering practice. [Bread board, Wrapping, Crimping, Soldering - types - selection of materials and safety precautions, soldering practice in connectors and general purpose PCB, Crimping.]
6. Printed circuit boards (PCB) [Types, Single sided, Double sided, PTH, Processing methods, Design and fabrication of a single sided PCB for a simple circuit with manual etching (Ferric chloride) and drilling.]
7. Assembling of electronic circuit/system on general purpose PCB, test and show the functioning(**Any Four circuits)**
   1. Fixed voltage power supply with transformer, rectifier diode, capacitor filter, zener/IC regulator.
   2. LED blinking circuit using a stable multi-vibrator with transistor BC 107.
   3. Square wave generation using IC 555 timer in IC base.
   4. Sine wave generation using IC 741 OP-AMP in IC base.
   5. RC coupled amplifier with transistor BC 107.
   6. AND and NAND gates in diode transistor logic.

8.Familiarization of electronic systems (**Any three systems)**

1. Setting up of a PA system with different microphones, loud speakers, mixer etc.
2. Assembling and dismantling of desktop computer/laptop/mobile phones.
3. Coil/Transformer winding.
4. Identify the subsystems of TV, DTH, CCTV, Cable TV, CRO, Function generator etc.
5. Screen printing and PCB pattern transfer
6. Soldering & de-soldering of SMD using hot air soldering station.
7. Introduction to robotics- Familiarization of components (motor, sensors, battery etc.) used in robotics and assembling of simple robotic configurations.

Expected outcome

Student can identify the active and passive electronic components. Student gets hands-on assembling, testing, assembling, dismantling, fabrication and repairing systems by making use of the various tools and instruments available in the Electronics Workshop.

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Course No.	Course Name	L-T-P-Credits	Year of Introduction
CS110	COMPUTER SCIENCE WORKSHOP	0-0-2-1	2016

Course Objectives

1. To familiarize students with basic hardware and software tools
2. To implement algorithms studied in the course Introduction to Computing & Problem Solving.
3. To learn the implementation of control structures, Iterations and recursive functions, Lists, Tuples and Dictionaries.
4. To implement operations of files.
5. To implement a small micro project using Python

List of Exercises / Experiments (Minimum of 8 mandatory)

List of Exercises:

Introduction: Familiarization of hardware components of a desktop computer (motherboard, cards, memory, slots, power, cables etc.) Familiarization of Operating systems and various tools, particularly those for scientific computing, open source tools etc.

Programming exercises in Python based on the course Introduction To Computing and Problem Solving (BE 101-05). The exercises may include programs using the following concepts–

1. **Decision making, branching and looping**
   1. Variables , Expressions & Conditional statements
   2. Iteration statements (While , For etc.)
2. **Function & Function calls**
   1. Function calls, Math functions
   2. Parameters and arguments
   3. Adding new functions, Recursion
3. **Strings**
   1. String traversal
   2. String searching, Comparison
   3. Other important String methods
4. **Lists, Tuples and Dictionaries**
   1. Traversing List, List Operations

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2. Creation of Dictionary and Operations
3. Lists and Tuples

5. Files and Operations

1. Files - defining, opening/closing, operations
2. Pickling

6. **Micro Project**: Students are expected to do a micro project by using Python, preferably related to the Web

Expected outcome

1. Students are able to identify common hardware components and their purpose
2. Students gain sufficient awareness about latest software tools.
3. Students are able to develop programs in Python for common problems of reasonable complexity.

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Course No:	Course Name	L-T-P-Credits	Year of Introduction
CH110	CHEMICAL ENGINEERING WORKSHOP	0-0-2-1	2016

Course Objectives

To impart in students the basic knowledge in chemical engineering through simple experiments and demonstrations.

List of Exercises / Experiments (Minimum of 8 mandatory)

1. Preparation of soap
2. Determination of flash and fire point
3. Preparation of Biodiesel
4. Specific gravity measurement
5. Fabrication of FRP laminates/ Study of filtration equipments
6. Study of distillation column
7. Study of absorption column
8. Study of heat exchanger
9. Study of size reduction equipment
10. Preparation of Pigment

Expected outcome

Students will have a thorough understanding of the basic concepts that they learn in the theory paper “Introduction to Chemical Engineering”.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
CS100	Computer Programming	2-1-0	2016

Course Objectives

To understand the fundamental concept of C programming and use it in problem solving.

Syllabus

Introduction to C language; Operators and expressions; Sorting and searching; Pointers; Memory allocation; Stacks and Queues.

Course Outcomes

1. Identify appropriate C language constructs to solve problems.
2. Analyze problems, identify subtasks and implement them as functions/procedures.
3. Implement algorithms using efficient C-programming techniques.
4. Explain the concept of file system for handling data storage and apply it for solving problems
5. Apply sorting & searching techniques to solve application programs.

References

1. Rajaraman V., Computer Basics and Programming in C, PHI.
2. Anita Goel and Ajay Mittal, Computer fundamentals and Programming in C., Pearson.
3. Gottfried B.S., Programming with C, Schaum Series, Tata McGraw Hill.
4. Horowitz and Sahni, Fundamentals of data structures - Computer Science Press.
5. Gary J. Bronson, ANSI C Programming, CENGAGE Learning India.
6. Stewart Venit and Elizabeth Drake, Prelude to Programming – Concepts & Design, Pearson.
7. Dromy R.G., How to Solve it by Computer, Pearson.
8. Kernighan and Ritche D.M., The C. Programming Language, PHI.

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COURSE PLAN

Module	Contents	Contact Hours	Sem.Exam Marks;%
I	Introduction to C Language: Preprocessor directives, header files, data types and qualifiers. Operators and expressions. Data input and output, control statements.	7	15%

II	Arrays and strings- example programs. Two dimensional arrays - matrix operations. Structure, union and enumerated data type.	8	15%
III	Pointers: Array of pointers, structures and pointers. Example programs using pointers and structures.	7	15%
	FIRST INTERNAL EXAM		
IV	Functions – function definition and function prototype. Function call by value and call by reference. Pointer to a function –. Recursive functions.	7	15%
	SECOND INTERNAL EXAM		
V	Sorting and Searching : Bubble sort, Selection sort, Linear Search and Binary search. Scope rules Storage classes. Bit-wise operations.	6	20%
VI	Data files – formatted, unformatted and text files. Command line arguments – examples.	7	20%
	END SEMESTER EXAM		

Course code	Course Name	L-T-P-Credits	Year of Introduction
CS120	Computer Programming Lab		2016

Course Objective:

To implement algorithms studied in the course ComputerProgramming

To learn the implementation of control structures, Iterations and recursive functions.

To implement operations on different types of files.

List of Exercises / Experiments

(For Computer Science and Engineering Branch)

The exercises may include the Programs using the following concepts.

1.Decision making, branching and looping
- if, if else statements
- switch, goto statements
- while, do, for

statements 2.Arrays and strings
- one-dimensional, two-dimensional, multidimensional arrays
- reading/writing strings
- operations on strings
- string handling

3.Functions
- user defined functions
- function calls, arguments & return values
- nesting of functions
- recursive functions
- passing arrays and strings to functions

4. Structures and unions
- copying and comparing structure variables
- arrays of structures
- arrays within structures
- structures with in structures
- structures and functions
- unions

5. Pointers
- pointers and arrays
- pointers and character strings
- array of pointers
- pointers and functions
- pointers and structures

6.Files, memory allocation, bit-level programming -files -defining, opening/closing, input -output operations
-command line arguments
-memory allocation functions

Course Outcome

Students will be able to analyse a problem, find appropriate programming language construct should be used and implement C program for the problem.

SYLLABUS

SEMESTER 3

Course No.	Course Name	L-T-P - Credits	Year of Introduction
MA201	LINEAR ALGEBRA AND COMPLEX ANALYSIS	3-1-0-4	2016

Prerequisite : Nil

Course Objectives

COURSE OBJECTIVES

- To equip the students with methods of solving a general system of linear equations.
- To familiarize them with the concept of Eigen values and diagonalization of a matrix which have many applications in Engineering.
- To understand the basic theory of functions of a complex variable and conformal Transformations**.**

Syllabus

Analyticity of complex functions-Complex differentiation-Conformal mappings-Complex integration-System of linear equations-Eigen value problem

Expected outcome .

At the end of the course students will be able to
(i) solve any given system of linear equations
(ii) find the Eigen values of a matrix and how to diagonalize a matrix
(iii) identify analytic functions and Harmonic functions.
(iv)evaluate real definite Integrals as application of Residue Theorem
(v) identify conformal mappings(vi) find regions that are mapped under certain Transformations

Text Book:

Erwin Kreyszig: Advanced Engineering Mathematics, 10th ed. Wiley

References:

1.Dennis g Zill&Patric D Shanahan-A first Course in Complex Analysis with Applications-Jones&Bartlet Publishers
2.B. S. Grewal. Higher Engineering Mathematics, Khanna Publishers, New Delhi.
3.Lipschutz, Linear Algebra,3e **(** Schaums **Series)**McGraw Hill Education India 2005
4.Complex variables introduction and applications-second edition-Mark.J.Owitz-Cambridge Publication

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Complex differentiation Text 1[13.3,13.4] Limit, continuity and derivative of complex functions	3	
	Analytic Functions	2	
	Cauchy–Riemann Equation(Proof of sufficient condition of analyticity & C R Equations in polar form not required)-Laplace's Equation	2	
	Harmonic functions, Harmonic Conjugate	2	15%
II	Conformal mapping: Text 1[17.1-17.4] Geometry of Analytic functions Conformal Mapping,	1	
	Mapping $w = z^2$ conformality of $w = e^z$.	2	15%

	The mapping $w = z + \frac{1}{z}$ Properties of $w = \frac{1}{z}$ Circles and straight lines, extended complex plane, fixed points Special linear fractional Transformations, Cross Ratio, Cross Ratio property-Mapping of disks and half planes Conformal mapping by $w = \sin z$ & $w = \cos z$ (Assignment: Application of analytic functions in Engineering)	1 3 3	
FIRST INTERNAL EXAMINATION			
III	Complex Integration. Text 1[14.1-14.4] [15.4&16.1] Definition Complex Line Integrals, First Evaluation Method, Second Evaluation Method Cauchy's Integral Theorem(without proof), Independence of path(without proof), Cauchy's Integral Theorem for Multiply Connected Domains (without proof) Cauchy's Integral Formula- Derivatives of Analytic Functions(without proof)Application of derivative of Analytical Functions Taylor and Maclaurin series(without proof), Power series as Taylor series, Practical methods(without proof) Laurent's series (without proof)	2 2 2 2 2	15%
IV	Residue Integration Text 1 [16.2-16.4] Singularities, Zeros, Poles, Essential singularity, Zeros of analytic functions Residue Integration Method, Formulas for Residues, Several singularities inside the contour Residue Theorem. Evaluation of Real Integrals (i) Integrals of rational functions of $\sin\theta$ and $\cos\theta$ (ii)Integrals of the type $\int_{-\infty}^{\infty} f(x)dx$ (Type I, Integrals from 0 to ∞) (Assignment : Application of Complex integration in Engineering)	2 4 3	15%
SECOND INTERNAL EXAMINATION			
V	Linear system of Equations Text 1(7.3-7.5) Linear systems of Equations, Coefficient Matrix, Augmented Matrix Gauss Elimination and back substitution, Elementary row operations, Row equivalent systems, Gauss elimination-Three possible cases, Row Echelon form and Information from it.	1 5	20%

	Linear independence-rank of a matrix Vector Space-Dimension-basis-vector space $\mathbf{R}^3$ Solution of linear systems, Fundamental theorem of non-homogeneous linear systems(Without proof)-Homogeneous linear systems (Theory only	2 1	
VI	Matrix Eigen value Problem Text 1.(8.1,8.3 &8.4) Determination of Eigen values and Eigen vectors-Eigen space Symmetric, Skew Symmetric and Orthogonal matrices –simple properties (without proof) Basis of Eigen vectors- Similar matrices Diagonalization of a matrix-Quadratic forms- Principal axis theorem(without proof) (Assignment-Some applications of Eigen values(8.2))	3 2 4	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks : 100 Exam Duration: 3 hours

The question paper will consist of 3 parts.

Part A will have 3 questions of 15 marks each uniformly covering modules I and II. Each question may have two sub questions.

Part B will have 3 questions of 15 marks each uniformly covering modules III and IV. Each question may have two sub questions.

Part C will have 3 questions of 20 marks each uniformly covering modules V and VI. Each question may have three sub questions.

Any two questions from each part have to be answered.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME201	MECHANICS OF SOLIDS	3-1-0-4	2016

Prerequisite: nil

Course Objectives:

1. To acquaint with the basic concepts of stress and deformation in solids.
2. To practice the methodologies to analyse stresses and strains in simple structural members, and to apply the results in simple design problems.

Syllabus

Analysis of deformable bodies : stress, strain, material behaviour, deformation in axially loaded bars, biaxial and triaxial deformation. Torsion of elastic circular members, design of shafts. Axial force, shear force and bending moment in beams. Stresses in beams: flexure and shear stress formulae, design of beams. Deflection of beams. Transformation equations for plane state of stress and strain, principal planes and stresses, Mohr's circle. Compound stresses: combined axial, flexural and shear loads – eccentric loading. Buckling: Euler's theory and Rankine's formula for columns.

Expected outcomes: At the end of the course students will be able to

1. Understand basic concepts of stress and strain in solids.
2. Determine the stresses in simple structural members such as shafts, beams, columns etc. and apply these results in simple design problems.
3. Determine principal planes and stresses, and apply the results to combined loading case.

Text Books:

1. Rattan, Strength of Materials, 2e McGraw Hill Education India, 2011
2. S.Jose, Sudhi Mary Kurian, Mechanics of Solids, Pentagon, 2015

References Books:

1. S. H. Crandal, N. C. Dhal, T. J. Lardner, An introduction to the Mechanics of Solids, McGraw Hill, 1999
2. R. C. Hibbeler, Mechanics of Materials, Pearson Education,2008
3. I.H. Shames, J. H. Pitarresi, Introduction to Solid Mechanics, Prentice Hall of India, 2006
4. James M.Gere, Stephen Timoshenko, Mechanics of Materials, CBS Publishers & Distributors, New Delhi,2012
5. F. Beer, E. R. Johnston, J. T. DeWolf, Mechanics of Materials, Tata McGraw Hill, 2011
6. A. Pytel, F. L. Singer, Strength of Materials, Harper & Row Publishers, New York,1998
7. E. P. Popov, T. A. Balan, Engineering Mechanics of Solids, Pearson Education, 2012
8. R. K. Bansal, Mechanics of solids, Laxmi Publications, 2004
9. P. N. Singh, P. K. Jha, Elementary Mechanics of Solids, Wiley Eastern Limited, 2012

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Introduction to analysis of deformable bodies – internal forces – method of sections – assumptions and limitations. Stress – stresses due to normal, shear and bearing loads – strength design of simple members. Definition of linear and shear strains.	3	15%
	Material behavior – uniaxial tension test – stress-strain diagrams concepts of orthotropy, anisotropy and inelastic behavior – Hooke's law for linearly elastic isotropic material under axial and shear deformation	3	
	Deformation in axially loaded bars – thermal effects – statically indeterminate problems – principle of superposition - elastic strain energy for uniaxial stress.	4	
II	Definition of stress and strain at a point (introduction to stress and strain tensors and its components only) – Poisson's ratio – biaxial and triaxial deformations – Bulk modulus - Relations between elastic	4	15%
	Torsion: Shafts - torsion theory of elastic circular bars – assumptions and limitations – polar modulus - torsional rigidity – economic cross-sections – statically indeterminate problems – shaft design for torsional load.	4	
FIRST INTERNAL EXAM			
III	Beams- classification - diagrammatic conventions for supports and loading - axial force, shear force and bending moment in a beam	2	15%
	Shear force and bending moment diagrams by direct approach	3	
	Differential equations between load, shear force and bending moment. Shear force and bending moment diagrams by summation approach – elastic curve – point of inflection.	5	
IV	Stresses in beams: Pure bending – flexure formula for beams assumptions and limitations – section modulus - flexural rigidity - economic sections – beam of uniform strength.	4	15%
	Shearing stress formula for beams – assumptions and limitations – design for flexure and shear.	4	
SECOND INTERNAL EXAM			
V	Deflection of beams: Moment-curvature relation – assumptions and limitations - double integration method – Macaulay's method - superposition techniques – moment area method and conjugate beam ideas for simple cases.	6	20%
	Transformation of stress and strains: Plane state of stress - equations of transformation - principal planes and stresses.	4	
VI	Mohr's circles of stress – plane state of strain – analogy between stress and strain transformation – strain rosettes	3	20%
	Compound stresses: Combined axial, flexural and shear loads – eccentric loading under tension/compression - combined bending and twisting loads.	4	

	Theory of columns: Buckling theory –Euler's formula for long columns – assumptions and limitations – effect of end conditions - slenderness ratio – Rankin's formula for intermediate columns.	3	
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

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Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME203	MECHANICS OF FLUIDS	3-1-0-4	2016

Prerequisite: nil

Course Objectives:

1. To study the mechanics of fluid motion.
2. To establish fundamental knowledge of basic fluid mechanics and address specific topics relevant to simple applications involving fluids
3. To familiarize students with the relevance of fluid dynamics to many engineering systems

Syllabus

Fluid Properties, Kinematics of fluid flow, Fluid Statics, Dynamics of fluid flow, Flow through pipes, Concept of Boundary Layer, Dimensional Analysis and Hydraulic similitude

Expected outcome: At the end of the course students will be able to

1. Calculate pressure variations in accelerating fluids using Euler's and Bernoulli's equations
2. Become conversant with the concepts of flow measurements and flow through pipes
3. Apply the momentum and energy equations to fluid flow problems.
4. Evaluate head loss in pipes and conduits.
5. Use dimensional analysis to design physical or numerical experiments and to apply dynamic similarity

Text Books:

1. Balachandran.P, Engineering Fluid Mechanics, PHI,2012
2. A S Saleem, Fluid Mechanics, Fathima Books,2016

References Books:

1. Cengel, Fluid Mechanics, McGraw Hill Education India 2014
2. Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, 2005
3. Modi P. N. and S. M. Seth, Hydraulics & Fluid Mechanics, S.B.H Publishers, New Delhi, 2002
4. Streeter V. L., E. B. Wylie and K. W. Bedford, Fluid Mechanics, Tata McGraw Hill, Delhi, 2010.
5. Joseph Karz, Introductory Fluid Mechanics, Cambridge University press,2010
6. Fox R. W. and A. T. McDonald, Introduction to Fluid dynamics, 5/e, John Wiley and Sons, 2009.
7. Shames I. H, Mechanics of Fluids, McGraw Hill, 1992.
8. White F.M., Fluid Mechanics, 6/e, Tata McGraw Hill, 2008

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Introduction: Fluids and continuum, Physical properties of fluids, density, specific weight, vapour pressure, Newton's law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids. Fluid Statics- Pressure-density-height relationship, manometers, pressure on plane and curved surfaces, center of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to uniform accelerations, measurement of pressure.	8	15%
II	Kinematics of fluid flow: Eulerian and Lagrangian approaches, classification of fluid flow, 1-D, 2-D and 3-D flow, steady, unsteady, uniform, non-uniform, laminar, turbulent, rotational, irrotational flows, stream lines, path lines, streak lines, stream tubes, velocity and acceleration in fluid, circulation and vorticity, stream function and potential function, Laplace equation, equipotential lines flow nets, uses and limitations,	8	15%
FIRST INTERNAL EXAM			
III	Dynamics of Fluid flow: Fluid Dynamics: Energies in flowing fluid, head, pressure, dynamic, static and total head, Control volume analysis of mass, momentum and energy, Equations of fluid dynamics: Differential equations of mass, energy and momentum (Euler's equation), Navier-Stokes equations (without proof) in rectangular and cylindrical co-ordinates, Bernoulli's equation and its applications: Venturi and Orifice meters, Notches and Weirs (description only for notches and weirs). Hydraulic coefficients, Velocity measurements: Pitot tube and Pitot-static tube.	10	15%
IV	Pipe Flow: Viscous flow: Reynolds experiment to classify laminar and turbulent flows, significance of Reynolds number, critical Reynolds number, shear stress and velocity distribution in a pipe, law of fluid friction, head loss due to friction, Hagen Poiseuille equation. Turbulent flow: Darcy- Weisbach equation, Chezy's equation Moody's chart, Major and minor energy losses, hydraulic gradient and total energy line, flow through long pipes, pipes in series, pipes in parallel, equivalent pipe, siphon, transmission of power through pipes, efficiency of transmission, Water hammer, Cavitation.	12	15%
SECOND INTERNAL EXAM			
V	Concept of Boundary Layer : Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layers, laminar sub layer, velocity profile, Von- Karman momentum integral equations for the boundary layers, calculation of drag, separation of boundary and methods of control.	10	20%

VI	Dimensional Analysis and Hydraulic similitude: Dimensional analysis, Buckingham's theorem, important dimensional numbers and their significance, geometric, Kinematic and dynamic similarity, model studies. Froude, Reynold, Weber, Cauchy and Mach laws- Applications and limitations of model testing, simple problems only	8	20%
END SEMESTER EXAM			

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Question Paper Pattern

Total marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

KTU Estd. 2014

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME205	THERMODYNAMICS	3-1-0-4	2016

Prerequisite: nil

Course Objectives:

1. To understand basic thermodynamic principles and laws
2. To develop the skills to analyze and design thermodynamic systems

Syllabus

Basic concepts, zeroth law of thermodynamics and thermometry, energy, first law of thermodynamics, second law of thermodynamics, entropy, irreversibility and availability, third law of thermodynamics pure substances, equations of state, properties of gas mixtures, Introduction to ideal binary solutions, general thermodynamic relationships, combustion thermodynamics

Expected outcome: At the end of the course the students will be able to

1. Understand the laws of thermodynamics and their significance
2. Apply the principles of thermodynamics for the analysis of thermal systems

Text Books

1. P.K.Nag, Engineering Thermodynamics, McGraw Hill,2013
2. E.Rathakrishnan Fundamentals of Engineering Thermodynamics, PHI,2005

References Books:

1 Y. A. Cengel and M. A.Boles,Thermodynamics an Engineering Approach,McGraw Hill, 2011
2 G.VanWylen, R.Sonntag and C.Borgnakke, Fundamentals of Classical Thermodynamics, John Wiley & Sons,2012
3. Holman J.P, Thermodynamics, McGraw Hill, 2004
4. M.Achuthan, Engineering Thermodynamics, PHI,2004

Steam Tables/Data book

5. R.S.Khurmi, Steam table with Mollier chart, S.Chand,2008

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Role of Thermodynamics in Engineering and Science -- Applications of Thermodynamics Basic Concepts - Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic System and Control Volume, Surrounding, Boundaries, Types of Systems, Universe, Thermodynamic properties, Process, Cycle, Thermodynamic Equilibrium, Quasi – static Process, State, Point and Path function. (Review only- self study) Zeroth Law of Thermodynamics, Measurement of Temperature- Thermometry, reference Points, Temperature Scales, Ideal gas temperature scale, Comparison of thermometers-Gas Thermometers, Thermocouple, Resistance thermometer Energy - Work - Pdv work and other types of work transfer, free expansion work, heat and heat capacity.	7	15%
II	Joule's Experiment- First law of Thermodynamics - First law applied to Non flow Process- Enthalpy- specific heats- PMM1, First law applied to Flow Process, Mass and Energy balance in simple steady flow process. Applications of SFEE, Transient flow –Filling and Emptying Process. (Problems), Limitations of the First Law.	8	15%
FIRST INTERNAL EXAM			
III	Second Law of Thermodynamics, Thermal Reservoir, Heat Engine, Heat pump - Performance factors, Kelvin-Planck and Clausius Statements, Equivalence of two statements, Reversibility, Irreversible Process, Causes of Irreversibility, Corollaries of second law, PMM2, Carnot's theorem and its corollaries, Absolute Thermodynamic Temperature scale. Clausius Inequality, Entropy- Causes of Entropy Change, Entropy changes in various thermodynamic processes, principle of increase of entropy and its applications, Entropy generation in open and closed system, Entropy and Disorder, Reversible adiabatic process- isentropic process	10	15%
IV	Available Energy, Availability and Irreversibility- Useful work, Dead state, Availability function, Availability and irreversibility in open and closed systems - Gouy-Stodola theorem , Third law of thermodynamics. Pure Substances, Phase Transformations, Triple point, properties during change of phase, T-v, p-v and p-T diagram of pure substance, p-v-T surface, Saturation pressure and Temperature, T-h and T-s diagrams, h-s diagrams or Mollier Charts, Dryness Fraction, steam tables. Property calculations using steam tables.	10	15%
SECOND INTERNAL EXAM			

V	The ideal Gas Equation, Characteristic and Universal Gas constants, Deviations from ideal Gas Model: Equation of state of real substances- Vander Waals Equation of State, Berthelot, Dieterici, and Redlich-Kwong equations of state , Virial Expansion, Compressibility factor, Law of corresponding state, Compressibility charts Mixtures of ideal Gases – Mole Fraction, Mass fraction, Gravimetric and volumetric Analysis, Dalton's Law of partial pressure, Amagat's Laws of additive volumes, Gibbs-Dalton's law -Equivalent Gas constant and Molecular Weight, Properties of gas mixtures: Internal Energy, Enthalpy, specific heats and Entropy, Introduction to real gas mixtures- Kay's rule. *Introduction to ideal binary solutions, Definition of solution, ideal binary solutions and their characteristics, Deviation from ideality, Raoult's Law, Phase diagram, Lever rule(*in this section numerical problems not)	11	20%
VI	General Thermodynamic Relations – Combined First and Second law equations – Helmholtz and Gibb's functions - Maxwell's Relations, Tds Equations. The Clapeyron Equation, equations for internal energy, enthalpy and entropy, specific heats, Throttling process, Joule Thomson Coefficient, inversion curve. #Introduction to thermodynamics of chemically reacting systems, Combustion, Thermochemistry – Theoretical and Actual combustion processes- Definition and significance of equivalence ratio, enthalpy of formation , enthalpy of combustion and heating value (#in this section numerical problems not included)	10	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
Approved steam tables permitted
The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME210	METALLURGY AND MATERIALS ENGINEERING	3-0-0-3	2016

Prerequisite: nil

Course Objectives:

1. To provide fundamental science relevant to materials
2. To provide physical concepts of atomic radius, atomic structure, chemical bonds, crystalline and non-crystalline materials and defects of crystal structures, grain size, strengthening mechanisms, heat treatment of metals with mechanical properties and changes in structure
3. To enable students to be more aware of the behavior of materials in engineering applications and select the materials for various engineering applications.
4. To understand the causes behind metal failure and deformation
5. To determine properties of unknown materials and develop an awareness to apply this knowledge in material design.

Syllabus:-Chemical bonds – crystallography- imperfections- crystallization- diffusion- phase diagrams-heat treatment – strengthening mechanisms- hot and cold working – alloying- ferrous and non ferrous alloys- fatigue-creep- basics, need, properties and applications of modern engineering materials.

Expected outcome: At the end of the course students will be able to

1. Identify the crystal structures of metallic materials.
2. Analyze the binary phase diagrams of alloys Fe-Fe_3C, etc.
3. Correlate the microstructure with properties, processing and performance of metals.
4. Recognize the failure of metals with structural change.
5. Select materials for design and construction.
6. Apply core concepts in materials science to solve engineering problems.

Text Books

1. Raghavan V, Material Science and Engineering, Prentice Hall,2004
2. Jose S and Mathew E V, Metallurgy and Materials Science, Pentagon, 2011

Reference

1 Anderson J.C. *et.al*., Material Science for Engineers,Chapman and Hall,1990
2 Clark and Varney, Physical metallurgy for Engineers, Van Nostrand,1964
3. Reed Hill E. Robert, Physical metallurgy principles, 4th Edn. Cengage Learning,2009
4. Avner H Sidney, Introduction to Physical Metallurgy, Tata McGraw Hill,2009
5. Callister William. D., Material Science and Engineering, John Wiley,2014
6. Dieter George E, Mechanical Metallurgy,Tata McGraw Hill,1976
7. Higgins R.A. - Engineering Metallurgy part - I – ELBS,1998
8. Myers Marc and Krishna Kumar Chawla, Mechanical behavior of materials, Cambridge University press,2008
9. Van Vlack -Elements of Material Science - Addison Wesley,1989
10. http://nptel.ac.in/courses/113106032/1
11. http://www.myopencourses.com/subject/principles-of-physical-metallurgy-2
12. http://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-

solid-state-chemistry-fall-2010/syllabus/
13. http://www.msm.cam.ac.uk/teaching/partIA.php

Course Plan

Module	Contents	Hours	Semester Exam. Marks
I	Earlier and present development of atomic structure; attributes of ionization energy and conductivity, electronegativity and alloying; correlation of atomic radius to strength; electron configurations; electronic repulsion Primary bonds: - characteristics of covalent, ionic and metallic bond: attributes of bond energy, cohesive force, density, directional and non-directional and ductility. properties based on atomic bonding:- attributes of deeper energy well and shallow energy well to melting temperature, coefficient of thermal expansion - attributes of modulus of elasticity in metal cutting process -Secondary bonds:- classification- hydrogen bond and anomalous behavior of ice float on water, application- atomic mass unit and specific heat, application. *(brief review only, no University questions and internal assessment from these portions).*	2	**15%**
	Crystallography:- Crystal, space lattice, unit cell- BCC, FCC, HCP structures - short and long range order - effects of crystalline and amorphous structure on mechanical properties.	1	
	Coordination number and radius ratio; theoretical density; simple problems - Polymorphism and allotropy.	1	
	Miller Indices: - crystal plane and direction *(brief review)* - Attributes of miller indices for slip system, brittleness of BCC, HCP and ductility of FCC - Modes of plastic deformation: - Slip and twinning.	1	
	Schmid's law, equation, critical resolved shear stress, correlation of slip system with plastic deformation in metals and applications.	1	
II	Mechanism of crystallization: Homogeneous and heterogeneous nuclei formation, under cooling, dendritic growth, grain boundary irregularity.	1	**15%**
	Effects of grain size, grain size distribution, grain shape, grain orientation on dislocation/strength and creep resistance - Hall - Petch theory, simple problems	1	
	Classification of crystal imperfections: - types of dislocation – effect of point defects on mechanical properties - forest of dislocation, role of surface defects on crack initiation.	1	

	Burgers vector –dislocation source, significance of Frank Read source in metals deformation - Correlation of dislocation density with strength and nano concept, applications.	1	
	Significance high and low angle grain boundaries on dislocation – driving force for grain growth and applications during heat treatment.	1	
	Polishing and etching to determine the microstructure and grain size.	1	
	Fundamentals and crystal structure determination by X – ray diffraction, simple problems –SEM and TEM.	1	
	Diffusion in solids, Fick's laws, mechanisms, applications of diffusion in mechanical engineering, simple problems.	1	
	FIRST INTERNAL EXAMINATION		
III	Phase diagrams: - Limitations of pure metals and need of alloying - classification of alloys, solid solutions, Hume Rothery`s rule - equilibrium diagram of common types of binary systems: five types.	2	**15%**
	Coring - lever rule and Gibb`s phase rule - Reactions: - monotectic, eutectic, eutectoid, peritectic, peritectoid.	1	
	Detailed discussion on Iron-Carbon equilibrium diagram with microstructure and properties changes in austenite, ledeburite, ferrite, cementite, special features of martensite transformation, bainite, spheroidite etc.	1	
	Heat treatment: - Definition and necessity – TTT for a eutectoid iron–carbon alloy, CCT diagram, applications - annealing, normalizing, hardening, spheroidizing.	1	
	Tempering:- austermpering, martempering and ausforming - Comparative study on ductility and strength with structure of pearlite, bainite, spherodite, martensite, tempered martensite and ausforming.	1	
	Hardenability, Jominy end quench test, applications- Surface hardening methods:- no change in surface composition methods :- Flame, induction, laser and electron beam hardening processes- change in surface composition methods :carburizing and Nitriding; applications.	2	

	Types of Strengthening mechanisms: - work hardening, equation - precipitation strengthening and over ageing- dispersion hardening.	1	
	Cold working: Detailed discussion on strain hardening; recovery; re-rystallization, effect of stored energy; re-crystallization temperature - hot working Bauschinger effect and attributes in metal forming.	1	**15%**
	Alloy steels:- Effects of alloying elements on steel: dislocation movement, polymorphic transformation temperature, alpha and beta stabilizers, formation and stability of carbides, grain growth, displacement of the eutectoid point, retardation of the transformation rates, improvement in corrosion resistance, mechanical properties	1	
IV	Nickel steels, Chromium steels etc. - Enhancement of steel properties by adding alloying elements: - Molybdenum, Nickel, Chromium, Vanadium, Tungsten, Cobalt, Silicon, Copper and Lead.	1	
	High speed steels:- Mo and W types, effect of different alloying elements in HSS	1	
	Cast irons: Classifications; grey, white, malleable and spheroidal graphite cast iron etc, composition, microstructure, properties and applications.	1	**15%**
	Principal Non ferrous Alloys: - Aluminum, Copper, Magnesium, Nickel, study of composition, properties, applications, reference shall be made to the phase diagrams whenever necessary.	1	
	SECOND INTERNAL EXAMINATION		
	Fatigue: - Stress cycles – Primary and secondary stress raisers - Characteristics of fatigue failure, fatigue tests, S-N curve.	1	
	Factors affecting fatigue strength: stress concentration, size effect, surface roughness, change in surface properties, surface residual stress.	1	
V	Ways to improve fatigue life – effect of temperature on fatigue, thermal fatigue and its applications in metal cutting	1	**20%**
	Fracture: – Brittle and ductile fracture – Griffith theory of brittle fracture – Stress concentration, stress raiser – Effect of plastic deformation on crack propagation.	1	
	transgranular, intergranular fracture - Effect of impact loading on ductile material and its application in forging, applications - Mechanism of fatigue failure.	1	

	Structural features of fatigue: - crack initiation, growth, propagation - Fracture toughness (definition only) - Ductile to brittle transition temperature (DBTT) in steels and structural changes during DBTT, applications.	1	
V1	Creep: - Creep curves – creep tests - Structural change:- deformation by slip, sub-grain formation, grain boundary sliding	1	**20%**
	Mechanism of creep deformation - threshold for creep, prevention against creep - Super plasticity: need and applications	1	
	Composites:- Need of development of composites - geometrical and spatial Characteristics of particles – classification - fiber phase: - characteristics, classifications - matrix phase:- functions – only need and characteristics of PMC, MMC, and CMC – applications of composites: aircraft applications, aerospace equipment and instrument structure, industrial applications of composites, marine applications, composites in the sporting goods industry, composite biomaterials..	2	
	Modern engineering materials: - only fundamentals, need, properties and applications of, intermetallics, maraging steel, super alloys, Titanium – introduction to nuclear materials, smart materials and bio materials.	2	
	Ceramics:-coordination number and radius ratios- AX, A_mX_p, $A_mB_mX_p$ type structures – applications.	1	

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
HS210	LIFE SKILLS	2-0-2	2016

Prerequisite : Nil

Course Objectives

- To develop communication competence in prospective engineers.
- To enable them to convey thoughts and ideas with clarity and focus.
- To develop report writing skills.
- To equip them to face interview & Group Discussion.
- To inculcate critical thinking process.
- To prepare them on problem solving skills.
- To provide symbolic, verbal, and graphical interpretations of statements in a problem description.
- To understand team dynamics & effectiveness.
- To create an awareness on Engineering Ethics and Human Values.
- To instill Moral and Social Values, Loyalty and also to learn to appreciate the rights of others.
- To learn leadership qualities and practice them.

Syllabus

Communication Skill: Introduction to Communication, The Process of Communication, Barriers to Communication, Listening Skills, Writing Skills, Technical Writing, Letter Writing, Job Application, Report Writing, Non-verbal Communication and Body Language, Interview Skills, Group Discussion, Presentation Skills, Technology-based Communication.

Critical Thinking & Problem Solving: Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving, Six thinking hats, Mind Mapping & Analytical Thinking.

Teamwork: Groups, Teams, Group Vs Teams, Team formation process, Stages of Group, Group Dynamics, Managing Team Performance & Team Conflicts.

Ethics, Moral & Professional Values: Human Values, Civic Rights, Engineering Ethics, Engineering as Social Experimentation, Environmental Ethics, Global Issues, Code of Ethics like ASME, ASCE, IEEE.

Leadership Skills: Leadership, Levels of Leadership, Making of a leader, Types of leadership, Transactions Vs Transformational Leadership, VUCA Leaders, DART Leadership, Leadership Grid & leadership Formulation.

Expected outcome

The students will be able to

- Communicate effectively.
- Make effective presentations.
- Write different types of reports.
- Face interview & group discussion.
- Critically think on a particular problem.
- Solve problems.
- Work in Group & Teams
- Handle Engineering Ethics and Human Values.
- Become an effective leader.

Resource Book:

Life Skills for Engineers, Complied by ICT Academy of Kerala, McGraw Hill Education (India) Private Ltd., 2016

References:

- Barun K. Mitra; (2011), *"Personality Development & Soft Skills*", First Edition; Oxford Publishers.
- Kalyana; (2015) "*Soft Skill for Managers*"; First Edition; Wiley Publishing Ltd.
- Larry James (2016); "*The First Book of Life Skills*"; First Edition; Embassy Books.
- Shalini Verma (2014); *"Development of Life Skills and Professional Practice"*; First Edition; Sultan Chand (G/L) & Company
- John C. Maxwell (2014); "The 5 Levels of Leadership", Centre Street, A division of Hachette Book Group Inc.

Course Plan

Module	Contents	Hours L-T-P L	P	Sem. Exam Marks
I	Need for Effective Communication, Levels of communication; Flow of communication; Use of language in communication; Communication networks; Significance of technical communication, Types of barriers; Miscommunication; Noise; Overcoming measures, Listening as an active skill; Types of Listeners; Listening for general content; Listening to fill up information; Intensive Listening; Listening for specific information; Developing effective listening skills; Barriers to effective listening skills. **Technical Writing:** Differences between technical and literary style, Elements of style; Common Errors, **Letter Writing:** Formal, informal and demi-official letters; business letters, **Job Application**: Cover letter, Differences between bio-data, CV and Resume, **Report Writing:** Basics of Report Writing; Structure of a report; Types of reports. **Non-verbal Communication and Body Language:** Forms of non-verbal communication; Interpreting body-language cues; Kinesics; Proxemics; Chronemics; Effective use of body language **Interview Skills**: Types of Interviews; Ensuring success in job interviews; Appropriate use of non-verbal communication, **Group Discussion**: Differences between group discussion and debate; Ensuring success in group discussions, **Presentation Skills**: Oral presentation and public speaking skills; business presentations, **Technology-based Communication:** Netiquettes: effective e-mail messages; power-point presentation; enhancing editing skills using computer software.	2 3	2 4 4	See evaluation scheme

II	Need for Creativity in the 21st century, Imagination, Intuition, Experience, Sources of Creativity, Lateral Thinking, Myths of creativity Critical thinking Vs Creative thinking, Functions of Left Brain & Right brain, Convergent & Divergent Thinking, Critical reading & Multiple Intelligence. Steps in problem solving, Problem Solving Techniques, Problem Solving through Six Thinking Hats, Mind Mapping, Forced Connections. Problem Solving strategies, Analytical Thinking and quantitative reasoning expressed in written form, Numeric, symbolic, and graphic reasoning, Solving application problems.	2 2	2 2	
III	Introduction to Groups and Teams, Team Composition, Managing Team Performance, Importance of Group, Stages of Group, Group Cycle, Group thinking, getting acquainted, Clarifying expectations. Group Problem Solving, Achieving Group Consensus. Group Dynamics techniques, Group vs Team, Team Dynamics, Teams for enhancing productivity, Building & Managing Successful Virtual Teams. Managing Team Performance & Managing Conflict in Teams. Working Together in Teams, Team Decision-Making, Team Culture & Power, Team Leader Development.	3 3	2 2	
IV	Morals, Values and Ethics, Integrity, Work Ethic, Service Learning, Civic Virtue, Respect for Others, Living Peacefully. Caring, Sharing, Honesty, Courage, Valuing Time, Cooperation, Commitment, Empathy, Self-Confidence, Character Spirituality, Senses of 'Engineering Ethics', variety of moral issued, Types of inquiry, moral dilemmas, moral autonomy, Kohlberg's theory, Gilligan's theory, Consensus and controversy, Models of Professional Roles, Theories about right action, Self-interest, customs and religion, application of ethical theories. Engineering as experimentation, engineers as responsible experimenters, Codes of ethics, Balanced outlook on. The challenger case study, Multinational corporations, Environmental ethics, computer ethics,	3 3 3	2 2	

	Weapons development, engineers as managers, consulting engineers, engineers as expert witnesses and advisors, moral leadership, sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers(India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers(IETE), India, etc.	3		
V	Introduction, a framework for considering leadership, entrepreneurial and moral leadership, vision, people selection and development, cultural dimensions of leadership, style, followers, crises. Growing as a leader, turnaround leadership, gaining control, trust, managing diverse stakeholders, crisis management Implications of national culture and multicultural leadership Types of Leadership, Leadership Traits. Leadership Styles, VUCA Leadership, DART Leadership, Transactional vs Transformational Leaders, Leadership Grid, Effective Leaders, making of a Leader, Formulate Leadership	4 2 2	 2 2	
END SEMESTER EXAM				

EVALUATION SCHEME

Internal Evaluation

(Conducted by the College)

Total Marks: 100

Part – A

(To be started after completion of Module 1 and to be completed by 30th working day of the semester)

1. Group Discussion – Create groups of about 10 students each and engage them on a GD on a suitable topic for about 20 minutes. Parameters to be used for evaluation is as follows;

(i) Communication Skills – 10 marks
(ii) Subject Clarity – 10 marks
(iii) Group Dynamics - 10 marks
(iv) Behaviors & Mannerisms - 10 marks

(Marks: 40)

Part – B

(To be started from 31st working day and to be completed before 60th working day of the semester)

2. Presentation Skills – Identify a suitable topic and ask the students to prepare a presentation (preferably a power point presentation) for about 10 minutes. Parameters to be used for evaluation is as follows;

(i)	Communication Skills*	-	10 marks
(ii)	Platform Skills**	-	10 marks
(iii)	Subject Clarity/Knowledge	-	10 marks

(Marks: 30)

* Language fluency, auditability, voice modulation, rate of speech, listening, summarizes key learnings etc.

** Postures/Gestures, Smiles/Expressions, Movements, usage of floor area etc.

Part – C

(To be conducted before the termination of semester)

3. Sample Letter writing or report writing following the guidelines and procedures. Parameters to be used for evaluation is as follows;

(i)	Usage of English & Grammar	-	10 marks
(ii)	Following the format	-	10 marks
(iii)	Content clarity	-	10 marks

(Marks: 30)

External Evaluation

(Conducted by the University)

Total Marks: 50 Time: 2 hrs.

Part – A

Short Answer questions

There will be one question from each area (five questions in total). Each question should be written in about maximum of 400 words. Parameters to be used for evaluation are as follows;

(i) Content Clarity/Subject Knowledge
(ii) Presentation style
(iii) Organization of content

(Marks: 5 x 6 = 30)

Part – B

Case Study

The students will be given a case study with questions at the end the students have to analyze the case and answer the question at the end. Parameters to be used for evaluation are as follows;

(i) Analyze the case situation
(ii) Key players/characters of the case
(iii) Identification of the problem (both major & minor if exists)
(iv) Bring out alternatives
(v) Analyze each alternative against the problem
(vi) Choose the best alternative
(vii) Implement as solution
(viii) Conclusion
(ix) Answer the question at the end of the case

(Marks: 1 x 20 = 20)

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
KTU
Estd.
2014

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME231	COMPUTER AIDED MACHINE DRAWING LAB	0-0-3-1	2016

Course Objectives:

1. To introduce students to the basics and standards of engineering drawing related to machines and components.
2. To teach students technical skills regarding assembly, production and part drawings.
3. To familiarize students with various limits, fits and tolerances.
4. To help students gain knowledge about standard CAD packages on modeling and drafting.

Syllabus

Introduction to Machine Drawing, Drawing Standards, Fits, Tolerances, Production drawings. Introduction to CAD, assembly drawings, etc.

Expected outcome

At the end of the course students will be able to

1. Acquire the knowledge of various standards and specifications about standard machine components.
2. Make drawings of assemblies with the help of part drawings given.
3. Ability to select, configure and synthesize mechanical components into assemblies.
4. Apply the knowledge of fits and tolerances for various applications.
5. Able to model components of their choice using CAD software.
6. Get exposure to advanced CAD packages.

Text Books:

1. N. D. Bhatt and V.M. Panchal, Machine Drawing, Charotar Publishing House,2014
2. K C John, Machine Drawing, PHI,2009
3. P I Vargheese and K C John, Machine Drawing, VIP Publishers ,2011
4. K.L.Narayana, P.Kannaiah & K. Venkata Reddy,Machine Drawing, New Age Publishers,2009
5. Ajeet Singh, Machine Drawing Includes AutoCAD, Tata McGraw-hill,2012
6. P S Gill, Machine Drawing, Kataria & Sons,2009

Course Plan		
Module	**Contents**	**Hours**
0	Introduction Principles of drawing, free hand sketching, manual drawing, CAD drawing etc.	01
I	Drawing standards**:** 2 exercises Code of practice for Engineering Drawing, BIS specifications – lines, types of lines, dimensioning, sectional views, Welding symbols, riveted joints, keys, fasteners –bolts, nuts, screws, keys etc.	05
II	Fits ,Tolerances and Surface Roughness**:** 2 exercises Limits, Fits – Tolerances of individual dimensions – Specification of Fits – basic principles of geometric & dimensional tolerances. Preparation of production drawings and reading of part and assembly drawings, surface roughness, indication of surface roughness, etc.	06
FIRST INTERNAL EXAM		
III	Introduction to drafting package: Introduction, input, output devices, introduction to drafting software like Auto CAD, basic commands and development of simple 2D and 3D drawings. Drawing, Editing, Dimensioning, Plotting Commands, Layering Concepts, Matching, Detailing, Detailed drawings.	06
IV	Assembly drawings(2D)**:** 10 exercises Preparation of assembled views. (Manually): Shaft couplings – Connecting rod - Machine Vice – Stuffing box – Plummer block. (Using software package, 2D Drawing) :– Universal joint - Screw jack – Lathe Tailstock – Rams Bottom Safety Valve – Steam stop valve. Preparation of Bill of materials and tolerance data sheet.	24
SECOND INTERNAL EXAM		
Note: 50% of assembly drawings (Module IV) must be done manually and remaining 50% of assembly drawings must be done using any 2D drafting package.		
FINAL INTERNAL EXAM		

Examination scheme

(1) End semester examination shall be for 30 marks and of 2 hours duration.

(2) End semester exam shall be based on Module IV. It shall be conducted as a CAD examination

(3) 50 marks are allotted for internal evaluation: first internal exam 25 marks, second internal exam 25 marks and class exercises 20 marks.

(4) The first internal exam will be based on modules I and II and the second internal exam will be a based on Module IV alone. (Both will be conducted as manual drawing examinations)

Course No.	Course Name	L-T-P-Credits	Year of Introduction
CE230	MATERIAL TESTING LAB	0-0-3-1	2016

Course Objectives:

1. To provide knowledge on mechanical behaviour of materials
2. To acquaint with the experimental methods to determine the mechanical properties of materials.

Syllabus

List of experiments:

1. Tension test on mild steel/ tor-steel/ high strength steel and cast iron using Universal Testing Machine and extensometers.
2. Tests on springs (Open and closed coiled)
3. Torsion pendulum (mild steel, aluminium and brass wires)
4. Hardness test (Brinell, Vickers and Rockwell)
5. Impact test (Izod and Charpy)
6. Torsion test on mild steel rods.
7. Shear test on mild steel rods.
8. Fatigue test – Study of testing machine.
9. Bending test on wooden beams.
10. Strut test (Column buckling experiment)
11. Verification of Clerk Maxwell's law of reciprocal deflection and determination of Young's modulus of steel.
12. Photo elastic methods for stress measurements.
13. Jominy hardenability test
14. Measurement using strain gauges
15. Determination of moment of inertia of rotating bodies

Note: A minimum of 10 experiments are mandatory.

Expected outcome: At the end of the course the students will be able to

1. Acquire the knowledge on mechanical behaviour of materials
2. Conduct experiments determine the mechanical properties of materials.

References Books:

1. G E Dieter. Mechanical Metallurgy, McGraw Hill,2013
2. Dally J W, Railey W P, Experimental Stress analysis , McGarw Hill,1991
3. Baldev Raj, Jayakumar T, Thavasimuthu M., Practical Non destructive testing, Narosa Book Distributors,2015

SYLLABUS

SEMESTER 4

Course No.	Course Name	L-T-P - Credits	Year of Introduction
MA202	Probability distributions, Transforms and Numerical Methods	3-1-0-4	2016

Prerequisite: Nil

Course Objectives

- To introduce the concept of random variables, probability distributions, specific discrete and continuous distributions with practical application in various Engineering and social life situations.
- To know Laplace and Fourier transforms which has wide application in all Engineering courses.
- To enable the students to solve various engineering problems using numerical methods.

Syllabus

Discrete random variables and Discrete Probability Distribution.
Continuous Random variables and Continuous Probability Distribution.
Fourier transforms.
Laplace Transforms.
Numerical methods-solution of Algebraic and transcendental Equations, Interpolation.
Numerical solution of system of Equations. Numerical Integration, Numerical solution of ordinary differential equation of First order.

Expected outcome .

After the completion of the course student is expected to have concept of
(i) Discrete and continuous probability density functions and special probability distributions.
(ii) Laplace and Fourier transforms and apply them in their Engineering branch
(iii) numerical methods and their applications in solving Engineering problems.

Text Books:

1. Miller and Freund's "Probability and statistics for Engineers"-Pearson-Eighth Edition.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley, 2015.

References:

1. V. Sundarapandian, "Probability, Statistics and Queuing theory", PHI Learning, 2009.
2. C. Ray Wylie and Louis C. Barrett, "Advanced Engineering Mathematics"-Sixth Edition.
3. Jay L. Devore, "Probability and Statistics for Engineering and Science"-Eight Edition.
4. Steven C. Chapra and Raymond P. Canale, "Numerical Methods for Engineers"-Sixth Edition-Mc Graw Hill.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Discrete Probability Distributions.** (Relevant topics in section 4.1,4,2,4.4,4.6 Text1)		
	Discrete Random Variables, Probability distribution function, Cumulative distribution function.	2	
	Mean and Variance of Discrete Probability Distribution.	2	
	Binomial Distribution-Mean and variance.	2	
	Poisson Approximation to the Binomial Distribution. Poisson distribution-Mean and variance.	2	15%

II	**Continuous Probability Distributions.** (Relevant topics in section 5.1,5.2,5.5,5.7 Text1) Continuous Random Variable, Probability density function, Cumulative density function, Mean and variance. Normal Distribution, Mean and variance (without proof). Uniform Distribution.Mean and variance. Exponential Distribution, Mean and variance.	 2 4 2 2	15%
FIRST INTERNAL EXAMINATION			
III	**Fourier Integrals and transforms. (**Relevant topics in section 11.7, 11.8, 11.9 Text2) Fourier Integrals. Fourier integral theorem (without proof). Fourier Transform and inverse transform. Fourier Sine & Cosine Transform, inverse transform.	 3 3 3	15%
IV	**Laplace transforms. (**Relevant topics in section 6.1,6.2,6.3,6.5,6.6 Text2**)** Laplace Transforms, linearity, first shifting Theorem. Transform of derivative and Integral, Inverse Laplace transform, Solution of ordinary differential equation using Laplace transform. Unit step function, second shifting theorem. Convolution Theorem (without proof). Differentiation and Integration of transforms.	 3 4 2 2 2	15%
SECOND INTERNAL EXAMINATION			
V	**Numerical Techniques**.(Relevant topics in section.19.1,19.2,19.3 Text2) Solution Of equations by Iteration, Newton- Raphson Method. Interpolation of Unequal intervals-Lagrange's Interpolation formula. Interpolation of Equal intervals-Newton's forward difference formula, Newton's Backward difference formula.	 2 2 3	20%
VI	**Numerical Techniques**. (Relevant topics in section 19.5,20.1,20.3, 21.1 Text2) Solution to linear System- Gauss Elimination, Gauss Seidal Iteration Method. Numeric Integration-Trapezoidal Rule, Simpson's 1/3 Rule. Numerical solution of firstorder ODE-Euler method, Runge-Kutta Method (fourth order).	 3 3 3	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks : 100 Exam Duration: 3 hours

The question paper will consist of 3 parts.

Part A will have 3 questions of 15 marks each uniformly covering modules I and II. Each question may have two sub questions.

Part B will have 3 questions of 15 marks each uniformly covering modules III and IV. Each question may have two sub questions.

Part C will have 3 questions of 20 marks each uniformly covering modules V and VI. Each question may have three sub questions.

Any two questions from each part have to be answered.

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Course code	Course Name	L-T-P-Credits	Year of Introduction
ME202	ADVANCED MECHANICS OF SOLIDS	3-1-0-4	2016

Prerequisite: ME201 Mechanics of solids

Course Objectives: The main objectives of the course are

1. To impart concepts of stress and strain analyses in a solid.
2. To study the methodologies in theory of elasticity at a basic level.
3. To acquaint with the solution of advanced bending problems.
4. To get familiar with energy methods for solving structural mechanics problems.

Syllabus

Introduction, concepts of stress, equations of equilibrium, strain components, strain-displacement relations, compatibility conditions, constitutive relations, boundary conditions, 2D problems in elasticity, Airy's stress function method, unsymmetrical bending of straight beams, bending of curved beams, shear center, energy methods in elasticity, torsion of non-circular solid shafts, torsion of thin walled tubes.

Expected outcome: At the end of the course students will be able to

1. Apply concepts of stress and strain analyses in solids.
2. Use the procedures in theory of elasticity at a basic level.
3. Solve general bending problems.
4. Apply energy methods in structural mechanics problems.

Text Books:

1. L. S. Sreenath, Advanced Mechanics of Solids, McGraw Hill,2008
2. S. M. A. Kazimi, Solid Mechanics, McGraw Hill,2008
3. S. Jose, Advanced Mechanics of Materials, Pentagon Educational Services,2013
4. L. Govindaraju ,TG Sitharaman, Applied elasticity for Engineers, NPTEL
5. U. Saravanan, Advanced Solid Mechanics, NPTEL
6. S. Anil Lal, Advanced Mechanics of Solids, Siva Publications and Distributions, 2017

References Books:

1. S. P. Timoshenko, J. N. Goodier, Theory of elasticity, McGraw Hill,1970
2. R.J. Atkin, and N. Fox, An introduction the theory of elasticity, Longman,1980
3. J. P. Den Hartog, Advanced Strength of Materials, McGraw Hill,1987
4. C. K. Wang, Applied Elasticity, McGraw Hill,1983
5. www.solidmechanics.org/contents.htm - Free web book on Applied Mechanics of Solids by A.F. Bower.

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Introduction to stress analysis in elastic solids - stress at a point – stress tensor – stress components in rectangular and polar coordinate systems - Cauchy's equations – stress transformation – principal stresses and planes - hydrostatic and deviatoric stress components, octahedral shear stress - equations of equilibrium	6	15%
	Displacement field – engineering strain - strain tensor *(basics only)* – analogy between stress and strain tensors - strain-displacement relations *(small-strain only)* – compatibility conditions	4	
II	Constitutive equations – generalized Hooke's law – equations for linear elastic isotropic solids - relation among elastic constants – Boundary conditions – St. Venant's principle for end effects – uniqueness theorem	4	15%
	2-D problems in elasticity - Plane stress and plane strain problems – stress compatibility equation - Airy's stress function and equation – polynomial method of solution – solution for bending of a cantilever with an end load	4	
FIRST INTERNAL EXAM			
III	Equations in polar coordinates (2D) – equilibrium equations, strain-displacement relations, Airy's equation, stress function and stress components *(only short derivations for examination)*	3	15%
	Application of stress function to Lame's problem and stress concentration problem of a small hole in a large plate *(only stress distribution)*	3	
	Axisymmetric problems – governing equations – application to thick cylinders,, rotating discs.	4	
IV	Unsymmetrical bending of straight beams *(problems having c/s with one axis of symmetry only)* – curved beams *(rectangular c/s only)* - shear center of thin walled open sections *(c/s with one axis of symmetry only)*	6	15%
	Strain energy of deformation – special cases of a body subjected to concentrated loads, moment or torque - reciprocal relation – strain energy of a bar subjected to axial force, shear force, bending moment and torque	3	
SECOND INTERNAL EXAM			
V	Maxwell reciprocal theorem – Castigliano's first and second theorems – virtual work principle – minimum potential energy theorem.	5	20%

	Torsion of non-circular bars: Saint Venant's theory - solutions for circular and elliptical cross-sections	4	
VI	Prandtl's method - solutions for circular and elliptical cross-sections - membrane analogy.	4	20%
	Torsion of thin walled tubes, thin rectangular sections, rolled sections and multiply connected sections	6	
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3 X10 marks = 30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3 X10 marks = 30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4 X 10 marks = 40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME204	THERMAL ENGINEERING	3-1-0-4	2016

Prerequisite: ME205 Thermodynamics

Course Objectives:

1. To acquire knowledge on the working of steam turbines, IC engines and gas turbines
2. To introduce the combustion process in IC engines
3. To understand air pollution from IC engines and its remedies.

Syllabus

Steam engineering, boilers, steam nozzles, steam turbines, internal combustion engines, performance testing of IC Engines, fuels and fuel combustion, air pollution from IC engines and remedies, combustion in I.C. engines, gas turbines

Expected outcome: At the end of the course the students will be able to

1. Integrate the concepts, laws and methodologies from the course in thermodynamics into analysis of cyclic processes
2. To apply the thermodynamic concepts into various thermal application like IC engines, steam turbines, compressors.

Text Books:

1. Rudramoorthy , Thermal Engineering, McGraw Hill Education India,2003
2. R.K Rajput, Thermal Engineering, Laxmi publications,2010

References Books:

1. V. Ganesan, Fundamentals of IC engines, Tata McGraw-Hill,2002
2. T.D. Eastop and A McConkey, Applied thermodynamics for engineering technology, Pearson education,1996
3. J.B.Heywood, I.C engine fundamentals. McGraw-Hill,2011
4. Gill, P.W., Smith, JR., J.H., and Ziurys, E.J Fundamentals of internal combustion engines Oxford and IBH,1959
5. Rathore**,** Thermal Engineering, McGraw Hill Education India, 2010

Steam Tables

6. R.S.Khurmi, Steam table with Mollier chart,S.Chand,2008

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Steam engineering- T- S diagram, Mollier chart, Steam cycles- Rankine cycle, Modified Rankine cycle, Relative efficiency, Improvement in steam cycles-Reheat, Regenerative and Binary vapor cycle Steam Boilers: Types of boilers –Cochran boiler, Babcock and Wilcox boiler, Benson boiler, La Mont boiler, Loeffler boiler, Velox boiler, Boiler Mountings and Accessories Steam nozzles:-Types of nozzle- Velocity of steam, mass flow rate, critical pressure ratio and its significance, effect of friction, super saturated flow	8	15%
II	Steam turbines: classification, compounding of turbines-pressure velocity variation, velocity diagrams, work done, efficiency, condition for maximum efficiency, multistage turbines-condition line, stage efficiency. Steam turbine performance-reheat factor, degree of reaction, cycles with reheating and regenerative heating, governing of turbines	8	15%
FIRST INTERNAL EXAM			
III	Internal combustion engines: classification of I.C. Engines- four stroke and two stroke I.C. Engines, Comparison of four stroke and two stroke Engine. Wankel Engine, Air standard cycle-Carnot cycle, Otto cycle; Diesel cycle, dual combustion cycle, comparison of Otto, diesel and dual combustion cycles. Stirling and Ericsson cycles, air standard efficiency, specific work output, work ratio, Actual cycle analysis, deviation of actual engine cycle from ideal cycle. Rotary engines, Stratified charge engine , super charging of SI and CI Engines – turbo charging. Variable specific heats.	10	15%
IV	Performance Testing of I C Engines: Indicator diagram, mean effective pressure. Torque, Engine power- BHP, IHP. Engine efficiency- mechanical efficiency, volumetric efficiency, thermal efficiency and relative efficiency, Specific fuel consumption. Testing of I C engines- Morse test, Heat balance test and Retardation test Fuels and fuel combustion: flash point and fire point, calorific value, Fuels for SI and CI engine, Important qualities of SI and CI engine fuels, Rating of SI engine and CI engine fuels, Dopes, Additives, Gaseous fuels, LPG, CNG, Biogas, Producer gas. Analysis of fuel combustion-A/F ratio, equivalence ratio, minimum quantity of air, flue gas analysis, excess air.	10	15%
SECOND INTERNAL EXAM			
V	Air pollution from I.C. Engine and its remedies**:** Pollutants from S.I. and C.I. Engines, Methods of emission control, alternative fuels for I.C. Engines; the blending of fuels, Bio fuels. Combustion in I.C. Engines: Combustion phenomena in S.I. engines; Ignition limits, stages of combustion in S.I. Engines, Ignition lag, velocity of flame propagation, auto ignition, detonation; effects of engine variables on detonation; theories of detonation, octane rating of fuels;	10	20%

	pre-ignition; S.I. engine combustion chambers. Stages of combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, Cetane rating; C.I. engine combustion chambers.		
VI	Gas turbines: classification, Thermodynamic analysis of gas turbine cycles-open , closed and semi closed cycle; ideal working cycle- Brayton cycle-P-v and T-s diagram, thermal efficiency. Effect of compressor and turbine efficiencies. Optimum pressure ratio for maximum specific work output with and without considering machine efficiencies. Comparison of gas turbine and IC engines, Analysis of open cycle gas turbine, Improvements of the basic gas turbine cycles-regeneration, intercooling and reheating-cycle efficiency and work output-Condition for minimum compressor work and maximum turbine work. Combustion chambers for gas turbines. pressure loss in combustion process and stability loop.	10	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME206	FLUID MACHINERY	2-1-0-3	2016

Prerequisite: ME203 Mechanics of Fluids

Course Objectives:

1. To acquire knowledge on hydraulic machines such as pumps and turbines
2. To understand the working of air compressors and do the analysis

Syllabus

Impact of jets, Hydraulic Turbines, Rotary motion of liquids, Rotodynamic pumps, Positive displacement pumps**,** , Compressors

Expected outcome: At the end of the course the students will be able to

1. Discuss the characteristics of centrifugal pump and reciprocating pumps
2. Calculate forces and work done by a jet on fixed or moving plate and curved plates
3. Know the working of turbines and select the type of turbine for an application.
4. Do the analysis of air compressors and select the suitable one for a specific application

Text Books:

1. Som, Introduction to Fluid Mechanics and Fluid Machines ,McGraw Hill Education India 2011
2. Bansal R. K., A Textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications,2005.

Reference Books:

1. Cengel Y. A. and J. M. Cimbala, Fluid Mechanics, Tata McGraw Hill, 2013
2. Yahya S. M, Fans, Blower and Compressor, Tata McGraw Hill, 2005.
3. Shepherd D. G, Principles of Turbo Machinery, Macmillan, 1969.
4. Stepanoff A. J, Centrifugal and Axial Flow Pumps, John Wiley & Sons, 1991.
5. Rajput R. K, Fluid Mechanics and Hydraulic Machines, S. Chand & Co.,2006.
6. Subramanya, Fluid mechanics and hydraulic machines, 1e McGraw Hill Education India,2010

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	Impact of jets: Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat and curve),– Series of vanes - work done and efficiency Hydraulic Turbines : Impulse and Reaction Turbines – Degree of reaction – Pelton Wheel – Constructional features - Velocity triangles – Euler's equation – Speed ratio, jet ratio and work done , losses and efficiencies, design of Pelton wheel – Inward and outward flow reaction turbines- Francis Turbine – Constructional features – Velocity triangles, work done and efficiencies.	7	15%
II	Axial flow turbine (Kaplan) Constructional features – Velocity triangles- work done and efficiencies – Characteristic curves of turbines – theory of draft tubes – surge tanks – Cavitation in turbines – Governing of turbines – Specific speed of turbine , Type Number– Characteristic curves, scale Laws – Unit speed – Unit discharge and unit power.	7	15%
FIRST INTERNAL EXAM			
III	Rotary motion of liquids – free, forced and spiral vortex flows Rotodynamic pumps- centrifugal pump impeller types,-velocity triangles-manometric head- work, efficiency and losses, H-Q characteristic, typical flow system characteristics, operating point of a pump. Cavitation in centrifugal pumps- NPSH required and available- Type number-Pumps in series and parallel operations. Performance characteristics- Specific speed-Shape numbers – Impeller shapes based on shape numbers.	7	15%
IV	Positive displacement pumps- reciprocating pump – Single acting and double acting- slip, negative slip and work required and efficiency- indicator diagram- acceleration head - effect of acceleration and friction on indicator diagram – speed calculation- Air vessels and their purposes, saving in work done to air vessels multi cylinder pumps. Multistage pumps-selection of pumps-pumping devices-hydraulic ram, Accumulator, Intensifier, Jet pumps, gear pumps, vane pump and lobe pump.	7	15%
SECOND INTERNAL EXAM			
V	Compressors: classification of compressors, reciprocating compressor-single stage compressor, equation for work with and without clearance volume, efficiencies, multistage compressor, intercooler, free air delivered (FAD)	7	20%
VI	Centrifugal compressor-working, velocity diagram, work done, power required, width of blades of impeller and diffuser, isentropic efficiency, slip factor and pressure coefficient, surging and chocking. Axial flow compressors:- working, velocity diagram, degree of reaction, performance. Roots blower, vane compressor, screw compressor.	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs
The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

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Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME220	MANUFACTURING TECHNOLOGY	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:-

1. To give an exposure to different techniques of casting and molds required.
2. To provide an exposure to different rolling processes and different rolled products
3. To familiarize with different forging methods, cautions to be adopted in die design.
4. To give an introduction to various work and tool holding devices used in manufacturing.
5. To introduce to the bending, shearing and drawing processes of sheet metal working and allied machines,
6. To give an understanding of welding metallurgy and weldability and to introduce various metal joining techniques.

SYLLABUS

Casting –patterns - Cores – Gating – Risering – Defects in Castings - Rolling –Defects in Rolled parts- forging – Coining – Heading – Piercing –Die Design– Extrusion Process– Extrusion Defects – Drawing Process -Principles of Location –Principles of Clamping – Types of Clamp -Sheet metal characteristics –Deep drawing –Spinning –Definition of Welding – Weldability – Solidification of Weld Metal – Heat Affected Zone – Welding Defects - Gas Welding -Arc Welding - Ultrasonic Welding – Friction Welding – Resistance Welding — Brazing- Soldering.

Expected outcomes: At the end of the course the students will be able to

1. Acquire knowledge in various casting processes and technology related to them.
2. Understand the rolling passes required for getting required shapes of rolled products.
3. Discuss important aspects of forging techniques
4. Discuss sheet metal working processes and their applications to produce various shapes and products.
5. Acquire knowledge in various types of welding processes.

Text books:-

1. Amitabha Ghosh and Ashok Kumar Mallick, Manufacturing Science Affiliated East West Press Ltd, New Delhi, 2002
2. S.Kalpakjian and Steven R Schimid, Manufacturing Engineering and Technology, Pearson,2001

Reference books:-

1. RAO, Manufacturing Technology-Vol 2 3e, McGraw Hill Education India, 2013
2. RAO, Manutacturing Technology-Vol 1 4e, McGraw Hill Education India, 2013
3. Cyril Donaldson and George H LeCain, Tool Design,TMH
4. Handbook of Fixture Design – ASTME
5. Campbell J. S., Principles of Manufacturing Materials and Processes, Tata McGraw Hill, 1999
6. P R Beeley, Foundry Technology, Elsevier, 2001
7. Richard W. Heine, Carl R. Loper, Philip C. Rosenthal, Principles of Metal Casting,

Tata McGraw-Hill Education, 2001
8. Paul Degarma E and Ronald A. Kosher ,Materials and Processes in Manufacturing, Wiley,20111
9. P. N. Rao,Manufacturing Technology Foundry, Forming and Welding, Tata McGraw-Hill Education,2011
10. HMT Production Technology, 1e McGraw Hill,2001

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Course Plan			
Module	**Contents**	**Hours**	**Semester Examination Marks**
I	Sand Casting – Sand Molds-Types of Molding Sands and Testing	1	15%
	Type of patterns - Pattern Materials	1	
	Cores –Types and applications –Sand Molding Machines	1	
	Gating System – Risering	1	
	Shell Mold Casting – Ceramic Mold Casting	1	
	Investment Casting – Vacuum Casting – Slush Casting	1	
	Pressure Casting – Die Casting – Centrifugal Casting	1	
	Design Considerations based on Various Shapes - Defects in Castings – simple problems in casting	1	
II	Principles of Rolling –Types of rolling mills, Mechanics of Flat Rolling	1	15%
	Roll Force and Power Requirement - Neutral Point	1	
	Hot and Cold Rolling	1	
	Defects in Rolled Plates - Rolling Mills	1	
	Ring Rolling – Thread Rolling	1	
	Applications- Rolling of tubes, wheels, axles and I-beams	1	
FIRST INTERNAL EXAM			
III	Classification of forging – Forging methods – Forging under sticking condition	1	15%
	Precision Forging – Coining – Heading – Piercing	1	
	Die Design:- Preshaping, Design Features, Draft Angles – Die Materials and Lubrication	1	
	Forging Machines – Forging Defects and tests	1	
	Extrusion Process - Hot Extrusion – Cold Extrusion	1	
	Impact Extrusion – Extrusion Defects – Drawing Process, wire drawing process	1	

IV	Principles Location - Degrees of Freedom, 3-2-1 principle of locating	1	15%
	Locating from Planes - Locating from Circular Surfaces	1	
	Concentric Locating - Principles of Clamping	1	
	Types of Clamps - Strap Clamps Slide Clamps - Swing Clamps - Hinge Clamps	1	
	Vacuum Clamping - Magnetic Clamping	1	
SECOND INTERNAL EXAM			
V	Sheet metal characteristics – Typical shearing	1	20%
	Bending Sheet and Plate – Spingback - Bending Force	1	
	Press Brake Forming - Tube Bending	1	
	Stretch Forming - Deep Drawing	1	
	Rubber forming - Spinning Shear Spinning - Tube Spinning	1	
	Definition of Welding - Weldability – Solidification of the Weld Metal	1	
	Heat Affected Zone – correlation of strength of welded joint with structure - Welding Defects	1	
VI	Gas Welding: – Flame Characteristics	1	20%
	Equipment, fluxes and filler rods	1	
	Arc Welding – Applications and Equipment	1	
	Electrodes	1	
	Shielded Metal Arc Welding – Submerged Arc Welding	1	
	GTAW – Plasma Arc Welding	1	
	Ultrasonic Welding – Friction Welding	1	
	Resistance Spot Welding	1	
	Resistance Seam Welding – Stud Welding – Percussion Welding - simple problems in welding	1	
	Brazing:- Filler Metals, Methods - Soldering:- Techniques, Types of Solders and Fluxes	1	
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
KTU
Estd.
2014

Course code	Course Name	L-T-P - Credits	Year of Introduction
HS200	Business Economics	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To familiarize the prospective engineers with elementary Principles of Economics and Business Economics.
- To acquaint the students with tools and techniques that are useful in their profession in Business Decision Making which will enhance their employability;
- To apply business analysis to the "firm" under different market conditions;
- To apply economic models to examine current economic scenario and evaluate policy options for addressing economic issues
- To gain understanding of some Macroeconomic concepts to improve their ability to understand the business climate;
- To prepare and analyse various business tools like balance sheet, cost benefit analysis and rate of returns at an elementary level

Syllabus

Business Economics - basic concepts, tools and analysis, scarcity and choices , resource allocation, marginal analysis, opportunity costs and production possibility curve. Fundamentals of microeconomics - Demand and Supply Analysis, equilibrium, elasticity, production and production function, cost analysis, break-even analysis and markets. Basics of macroeconomics - the circular flow models, national income analysis, inflation, trade cycles, money and credit, and monetary policy. Business decisions - investment analysis, Capital Budgeting decisions, forecasting techniques and elementary Balance Sheet and taxation, business financing, international investments

Expected outcome .

A student who has undergone this course would be able to

i. make investment decisions based on capital budgeting methods in alignment with microeconomic and macroeconomic theories.
ii. able to analyse the profitability of the firm, economy of operation, determination of price under various market situations with good grasp on the effect of trade cycles in business.
iii. gain knowledge on Monetary theory, measures by RBI in controlling interest rate and emerging concepts like Bit Coin.
iv. gain knowledge of elementary accounting concepts used for preparing balance sheet and interpretation of balance sheet

Text Books

1. Geetika, Piyali Ghosh and Chodhury, *Managerial Economics*, Tata McGraw Hill, 2015
2. Gregory Mankiw, *Principles of Macroeconomics*, Cengage Learning, 2006.
3. M.Kasi Reddy and S.Saraswathi, *Economics and Financial Accounting*. Prentice Hall of India. New Delhi.

References:

1. Dornbusch, Fischer and Startz, *Macroeconomics*, McGraw Hill, 11th edition, 2010.
2. Khan M Y, *Indian Financial System*, Tata McGraw Hill, 7th edition, 2011.
3. Samuelson, *Managerial Economics*, 6th edition, Wiley
4. Snyder C and Nicholson W, *Fundamentals of Microeconomics*, Cengage Learning (India), 2010.
5. Truett, Managerial Economics: Analysis, Problems, Cases, 8th Edition, Wiley
6. Welch, *Economics: Theory and Practice* 7th Edition, Wiley
7. Uma Kapila, *Indian Economy Since Independence, 26th Edition: A Comprehensive and Critical Analysis of India's Economy*, 1947-2015
8. C Rangarajan, *Indian Economy, Essays on monetary and finance*, UBS Publishers'Distributors, 1998
9. A.Ramachandra Aryasri, *Managerial Economics and Financial Analysis*, Tata McGraw-Hill, New Delhi.
10. Dominick Salvatore, *Managerial Economics in Global Economy*, Thomas Western College Publishing, Singapore.
11. I.M .Pandey, *Financial Management*, Vikas Publishing House. New Delhi.
12. Dominick Salvatore, *Theory and Problems of Micro Economic Theory.* Tata Mac Graw-Hill, New Delhi.
13. T.N.Hajela.*Money, Banking and Public Finance.* Anne Books. New Delhi.
14. G.S.Gupta. *Macro Economics-Theory and Applications.* Tata Mac Graw- Hill, New Delhi.
15. Yogesh, Maheswari, *Management Economics* , PHI learning, NewDelhi, 2012
16. Timothy Taylor , *Principles of Economics*, 3rd edition, TEXTBOOK MEDIA.
17. Varshney and Maheshwari. *Managerial Economics*. Sultan Chand. New Delhi

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Business Economics** and its role in managerial decision making-meaning-scope-relevance-economic problems-scarcity Vs choice (2 Hrs)-Basic concepts in economics-scarcity, choice, resource allocation- Trade-off-opportunity cost-marginal analysis- marginal utility theory, Law of diminishing marginal utility -production possibility curve (2 Hrs)	4	15%
II	**Basics of Micro Economics I** Demand and Supply analysis-equillibrium-elasticity (demand and supply) (3 Hrs.) -Production concepts-average product-marginal product-law of variable proportions- Production function-Cobb Douglas function-problems (3 Hrs.)	6	15%
FIRST INTERNAL EXAMINATION			
III	**Basics of Micro Economics II** Concept of costs-marginal, average, fixed, variable costs-cost curves-shut down point-long run and short run (3 Hrs.)- Break Even Analysis-Problem-Markets-Perfect Competition, Monopoly and Monopolistic Competition, Oligopoly-Cartel and collusion (3 Hrs.).	6	15%
IV	**Basics of Macro Economics** - Circular flow of income-two sector and multi-sector models- National Income Concepts-Measurement methods-problems-Inflation, deflation (4 Hrs.)-Trade cycles-Money-stock and flow concept-Quantity theory of money-Fischer's Equation and Cambridge Equation -velocity of circulation of money-credit control methods-SLR, CRR, Open Market Operations-Repo and Reverse Repo rate-emerging concepts in money-bit coin (4 Hrs.).	8	15%

SECOND INTERNAL EXAMINATION			
V	**Business Decisions I**-Investment analysis-Capital Budgeting-NPV, IRR, Profitability Index, ARR, Payback Period (5 Hrs.)- Business decisions under certainty-uncertainty-selection of alternatives-risk and sensitivity- cost benefit analysis-resource management (4 Hrs.).	9	20%
VI	**Business Decisions II** Balance sheet preparation-principles and interpretation-forecasting techniques (7 Hrs.)-business financing-sources of capital- Capital and money markets-international financing-FDI, FPI, FII-Basic Principles of taxation-direct tax, indirect tax-GST (2 hrs.).	9	20%
END SEMESTER EXAM			

Question Paper Pattern

Max. marks: 100, Time: 3 hours

The question paper shall consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME232	THERMAL ENGINEERING LABORATORY	0-0-3-1	2016

Prerequisite : Should have registered for ME204 Thermal Engineering

Course Objectives:

1. To study the various types IC engines and their parts
2. To conduct the performance test on IC engines, compressors and blowers
3. To familiarize equipment used for measuring viscosity, flash and fire point and Calorific value of petroleum products

Syllabus

List of experiments:

Study of I.C engines :-

a) Diesel engines - all systems and parts

b) Petrol engines - all systems and parts

Experiments

1. Determination of flash and fire points of petroleum products -flash and fire point apparatus
2. Determination of viscosity of lubricating oil- viscometer
3. Determination of calorific value of solid and liquid fuels- calorimeter
4. Determination of calorific value of and gaseous fuels - calorimeter
5. Performance test on petrol engines with various types of loading systems
6. Performance test on Diesel engines with various types of loading systems
7. Heat Balance test on petrol/Diesel engines
8. Cooling curve of IC engines
9. Valve timing diagram of IC engines
10. Economic speed test on IC engines
11. Retardation test on IC engines
12. Determination volumetric efficiency and Air-fuel ratio of IC engines
13. Morse test on petrol engine
14. Performance test on reciprocating compressor
15. Performance test on rotary compressor/blower
16. Draw velocity profile in a pipe flow using Prandtl -Pitot tube
17. Analysis of automobile exhaust gas and flue gas using exhaust gas analyser

Note: 12 experiments are mandatory

Expected outcome: At the end of the course the students will be able to

1. Determine the efficiency and plot the characteristic curves of different types of Internal Combustion engines, compressors and blowers
2. Conduct experiments for the determination of viscosity, calorific value etc of petroleum products

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME230	FLUID MECHANICS AND MACHINES LABORATORY	0-0-3-1	2016

Prerequisite: ME203 Mechanics of fluids

Course Objectives: The main objectives of this course is to demonstrate the applications of theories of basic fluid mechanics and hydraulic machines and to provide a more intuitive and physical understanding of the theory.

Syllabus

Study:

1. Study of flow measuring equipments - water meters, venturi meter, orifice meter, current meter, rotameter
2. Study of gauges - pressure gauge, vacuum gauge, manometers.
3. Study of valves - stop valve, gate valve and foot valve.
4. Study of pumps – Centrifugal, Reciprocating, Rotary, Jet.
5. Study of Turbines - Impulse and reaction types.
6. Study of Hydraulic ram, accumulator etc.

List of Experiments:

1. Determination of coefficient of discharge and calibration of Notches
2. Determination of coefficient of discharge and calibration of Orifice meter
3. Determination of coefficient of discharge and calibration of Venturimeter.
4. Determination of Chezy's constant and Darcy's coefficient on pipe friction apparatus
5. Determination of hydraulic coefficients of orifices
6. Determination of metacentric height and radius of gyration of floating bodies.
7. Experiments on hydraulic ram
8. Reynolds experiment
9. Bernoulli's experiment
10. Experiment on Torque converter
11. Performance test on positive displacement pumps
12. Performance test on centrifugal pumps, determination of operating point and efficiency
13. Performance test on gear pump
14. Performance test on Impulse turbines
15. Performance test on reaction turbines (Francis and Kaplan Turbines)
16. Speed variation test on Impulse turbine
17. Determination of best guide vane opening for Reaction turbine
18. Impact of jet

Note: 12 experiments are mandatory

Expected outcome: At the end of the course the students will be able to

1. Discuss physical basis of Bernoulli's equation, and apply it in flow measurement (orifice, Nozzle and Venturi meter), and to a variety of problems
2. Determine the efficiency and plot the characteristic curves of different types of pumps and turbines.

SYLLABUS

SEMESTER 5

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME301	MECHANICS OF MACHINERY	3-1-0-4	2016

Prerequisite : Nil

Course Objectives

To provide knowledge on kinematics of selected mechanisms, design of cams, theory and analysis of gears, gear trains and synthesis of mechanisms.

Syllabus

Introduction to kinematics and mechanisms - different mechanisms, displacement, velocity, and acceleration analysis. Cam and followers - displacement, velocity, and acceleration analysis, cam profile synthesis. Gears – law of gearing, interference, gear trains, applications. Kinematic synthesis - dimensional synthesis, graphical synthesis, position synthesis, analytical synthesis, case study.

Expected outcome .

The students will be able to solve practical problems related to kinematics of mechanisms

Text Books:

1. Ballaney P. L., Theory of Machines and Mechanisms, Khanna Publishers,2005
2. S. S. Rattan, Theory of Machines, Tata Mc Graw Hill,2009

References:

1. C. E. Wilson, P. Sadler, Kinematics and Dynamics of Machinery, Pearson Education,2005
2. D. H. Myszka, Machines and Mechanisms Applied Kinematic Analysis, Pearson Education,2013
3. G. Erdman, G. N. Sandor, Mechanism Design: Analysis and synthesis Vol I & II, Prentice Hall of India,1984.
4. Ghosh, A. K. Malik, Theory of Mechanisms and Machines, Affiliated East West Press,1988
5. J. E. Shigley, J. J. Uicker, Theory of Machines and Mechanisms, McGraw Hill,2010

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to kinematics and mechanisms - various mechanisms, kinematic diagrams, degree of freedom- Grashof's criterion, inversions, coupler curves	3	15%
	straight line mechanisms exact, approximate – Ackerman Steering Mechanism - Hooke's joint - Geneva mechanism - mechanical advantage, transmission angle	4	
	Displacement, velocity and acceleration analysis - relative motion - relative velocity - instant centre -Kennedy's theorem	4	
II	Relative acceleration - Coriolis acceleration - graphical and analytical methods – complex number methods - computer oriented methods.	4	15%
	Cams - classification of cam and followers - displacement diagrams, velocity and acceleration analysis of SHM, uniform velocity, uniform acceleration, cycloidal motion	4	
FIRST INTERNAL EXAMINATION			
III	Graphical cam profile synthesis, pressure angle	2	15%

	Analysis of tangent cam with roller follower and circular cam with flat follower	6	
	Introduction to polynomial cams.	2	
IV	Gears – terminology of spur gears – law of Gearing - involute spur gears involutometry - contact ratio - interference - backlash - gear standardization - interchangability	4	15%
	Non-standard gears, centre distance modification, long and short addendum system. - internal gears - theory and details of bevel, helical and worm gearing	4	
SECOND INTERNAL EXAMINATION			
V	Gear trains - simple and compound gear trains - planetary gear trains – differential -solution of planetary gear train problems - applications	5	20%
	Kinematic synthesis (planar mechanisms) - tasks of kinematic synthesis – type, number and dimensional synthesis – precision points	4	
VI	Graphical synthesis for motion - path and prescribed timing - function generator .	3	20%
	2 position and 3 position synthesis – overlay Method	3	
	Analytical synthesis techniques, Freudenstein's equation – complex number methods - one case study in synthesis of mechanism.	4	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: in all parts each question can have a maximum of four sub questions

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME303	MACHINE TOOLS AND DIGITAL MANUFACTURING	3-0-0-3	2016

Prerequisite: Nil

Course Objectives: The main objectives of this course are

1. To introduce students to the scientific principles underlying material behavior during manufacturing processes so as to enable them to undertake calculations of forces, tool stresses and material removal rates.
2. To understand various machine tools such as lathe, drilling machine, reciprocating machines etc. and their operations.
3. To impart knowledge of appropriate parameters to be used for various machining operations.
4. To develop knowledge on the importance of milling grinding and super finishing in metal cutting process.
5. To introduce the fundamentals of digital manufacturing.

Syllabus

Introduction to metal cutting, Mechanism of metal removal, Merchants theory, Frictional forces in metal cutting, Thermal aspects of machining, General purpose machine tools, Principle and operation of lathe, Drilling machines, Reciprocating machines, Milling machines, Grinding machines, Super finishing operations, Semi-automatic machine tools, Single and multi-spindle machines, Introduction to digital manufacturing and digital manufacturing science.

Expected outcomes:

The students will be able to

1. Analyze various machining process and calculate relevant quantities such us velocities, forces and powers.
2. Identify and explain the function of the basic components of a machine tool.
3. Understand the limitations of various machining process with regard to shape formation and surface texture.
4. Apply cutting mechanics to metal machining based on cutting force and power consumption.
5. Understand the use of various machine tools and their fields of application.
6. Understand the principle and applications of grinding and super finishing operations.
7. Get a basic knowledge on the importance of digital manufacturing.

Text books

1. Chapman W. A. J., Workshop Technology, Viva books (P) Ltd,1988
2. HMT, Production Technology, Tata McGraw-Hill,2001
3. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited,2012

Reference books

1. Acharkan. N., Machine Tool Design Vol. 1 to 4, MIR Publication,2000
2. Chernov, Machine Tools, MIR Publication,1984
3. Ghosh A. And Malic A. K., Manufacturing Science, East West Press, 2010
4. Hajra Choudary, Elements of workshop technology, Vol I & II, Media Publishers, 2010
5. Lihui Wang and Andrew Yeh Ching Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009
6. Malkin Stephen, Grinding Technology: Theory and Applications of Machining with Abrasives, Industrial press, 2008
7. Poul De Garmo, J.T.Black, R.A.Kosher, Materials and Processes in Manufacturing, Prentice Hall of India Pvt. Ltd.,1997.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to metal cutting: Tool nomenclature – Attributes of each tool nomenclature – Attributes of feed and tool nomenclature on surface roughness obtainable	1	15%
	Orthogonal and oblique cutting - Mechanism of metal removal – Primary and secondary deformation shear zones	1	
	Mechanism of chip formation – Types of chips, need and types of chip breakers – Merchant's theory	1	
	Analysis of cutting forces in orthogonal cutting– Work done, power required (simple problems)	1	
	Friction forces in metal cutting – development of cutting tool materials	1	
	Thermal aspects of machining -Tool wear and wear mechanisms	1	
	Factors affecting tool life– Economics of machining (simple problems) Cutting fluids	1 1	
II	General purpose machine tools – Principle and operation of lathe – Types of lathes and size specification	1	15%
	Work holding parts of lathes and their functions – Main operations	1	
	Taper turning and thread cutting – Attachments	1	
	Feeding mechanisms, Apron mechanisms	1	
	Drilling Machines – Types – Work holding devices	1	
	Tool holding devices – Drill machine operations	1	
	Drilling machine tools – Twist drill nomenclature- cutting forces in drilling.	1	
FIRST INTERNAL EXAMINATION			
III	Reciprocating machines: Shaping machines – Types – Size – Principal parts – Mechanism	1	15%
	Work holding devices – Operations performed – Tools	1	

	Cutting speed, feed and depth of cut – Machining time.	1	
	Slotting machines – Types – Size – Principal parts – Mechanism – Work holding devices	1	
	Operations performed – Tools – Cutting speed, feed and depth of cut	1	
	Planing machines – Types – Size – Principal parts – Mechanism – Work holding devices	1	
	Operations performed – Tools – Cutting speed, feed and depth of cut – Machining time- Surface roughness obtainable.	1	
IV	Milling machines – Types – Principal parts – Milling mechanism	1	15%
	Work holding devices – Milling machine attachments	1	
	Types of milling cutters – Elements of plain milling cutters	1	
	Nomenclature - Cutting forces in milling – Milling cutter materials	1	
	Up milling, down milling and face milling operations	1	
	Calculation of machining time	1	
	Indexing – Simple indexing – Differential indexing	1	
SECOND INTERNAL EXAMINATION			
V	Grinding machines – Classification – Operations – Surface, cylindrical and centreless grinding	1	20%
	Grinding mechanisms – Grinding wheels: Specification – types of abrasives, grain size	1	
	Types of bond, grade, structure – Marking system of grinding wheels – Selection of grinding wheels	1	
	Glazing and loading of wheels – Dressing and Truing of grinding wheels, surface roughness obtainable	1	
	Superfinishing operations: Lapping operation– Types of hand lapping – Lapping machines – Types of honing –Methods of honing	1	
	Types of honing stones – Honing conditions – Cutting fluids – Types of broaches – Force required for broaching – Surface roughness obtainable in lapping, honing and broaching operations.	1	
	Semi-automatic machine tools – Turret and capstan lathes. Automatic machine tools – Single and multi-spindle machines.	1	
V1	Introduction to Digital Manufacturing: Concepts and research and development status of digital manufacturing	1	20%
	Definition of digital manufacturing – Features and development of digital manufacturing.	1	
	Theory system of digital manufacturing science: Operation Mode and Architecture of Digital Manufacturing System	1	
	Operation reference mode of digital manufacturing system – Architecture of digital manufacturing system	1	
	Modeling theory and method of digital manufacturing science	1	
	Critical modeling theories and technologies of digital manufacturing science	1	
	Theory system of digital manufacturing science – Basic	1	

	architecture model of digital manufacturing system.		
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: in all parts each question can have a maximum of four sub questions

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME305	COMPUTER PROGRAMMING & NUMERICAL METHODS	2-0-1-3	2016

Prerequisite: Nil

Course Objectives:

- To equip students with fundamentals of computer programming
- To provide fundamental idea about the use of computer programming and numerical methods for analyzing the basic engineering problems.

Syllabus

Introduction to computer programming concept, control statements, basics pointers, Introduction to Class and Object, Errors and approximations, curve fitting, Solution of Partial differential equations, Numerical problems and preparation of computer programs.

Expected outcomes:

- The students will be able to write computer programs for numerical solutions for engineering problems like system of equations and heat equations..

Text Books

1. Balagurusamy, Computer Programming 1e McGraw Hill Education , 2013
2. Balagurusamy, Numerical Methods 1e McGraw Hill Education, 1999
3. Jose S., Computer Programming and Numerical Methods, Pentagon, 2015.
4. Ravichandran D., Programming with C++, Tata McGraw Hill, 2007.

Reference Books

1. Balaguruswamy E., Object Oriented Programming with C++, Tata McGraw Hill, 1992.
2. Barkakati N., Object Oriented Programming in C++, SAMS, 1991.
3. Gerald C. F. and P. O. Wheatley, Applied Numerical Analysis, Pearson,2004.
4. Kamthane A. M., Object Oriented Programming with ANSI & Turbo C++,
5. Lippman S. B. and J. Lajoie, C++ Primer, Pearson Education, 2005.
   Pearson Education, 2009.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Computer programming concept –internal representation of data - Algorithm and flow chart, Basics of procedure oriented and object oriented programming. Introduction to C++: Structure of C++ program; Keywords; Identifiers; Data types – integer, real, character, string, boolean, enumeration, Constant and Variables; Operators – assignment, arithmetic, relational, logical, increment, decrement and conditional operators; Statements – simple & compound, declaration statements. Input and output streams.	5	15%
II	Control statements: **`if`**, **`if-else`**, **`switch`**, **`for`**, **`while`**, **`do-while`**, **`break`** and **`continue`** statements, Arrays – one dimensional & two dimensional; Functions: inline functions, function over loading, Functions with default arguments, recursion.	7	15%
FIRST INTERNAL EXAM			

III	Basics of Pointers. Function call by value, call by reference. Preparation of programs for evaluation of Factorial of a number, infinite series, Sorting, Searching and Matrix multiplication.	8	15%
IV	Introduction to Class and Object- definition, data members, member function. private & public member functions, member access, friend declaration, class objects, predefined classes, initialization. Inheritance- base class and derived class. Simple programs using the above features. (No programming questions for University examination and internals)	7	15%
SECOND INTERNAL EXAM			
V	Errors and approximations, sources of errors. Solution of linear system of equations: Gauss elimination, Gauss-Jordan and Gauss–Seidel methods. Interpolation: Lagrange and Aitken techniques.	7	20%
VI	Curve fitting: method of least squares, non-linear relationships, Linear correlation, measures of correlation. Solution of Partial differential equations: classification, Laplace equation, Finite difference method. Numerical problems and preparation of computer programs for the above methods	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code.	Course Name	L-T-P - Credits	Year of Introduction
EE311	ELECTRICAL DRIVES & CONTROL FOR AUTOMATION	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

1. To understand the basic concepts of different types of electrical machines and their performance.
2. To know the different methods of starting D.C motors and induction motors.
3. To introduce the controllers for automation

.

Syllabus

DC Machines, transformers, three phase induction motor, single phase induction motor, stepper motor, controllers for automation.

Expected outcome .

The students will be able to

1. Select a drive for a particular application based on power rating.
2. Select a drive based on mechanical characteristics for a particular drive application.
3. Discuss the controllers used for automation

Text Books:

1. Kothari D. P. and I. J. Nagrath, Electrical Machines, Tata McGraw Hill, 2004.
2. Nagrath .I.J. & Kothari .D.P, Electrical Machines, Tata McGraw-Hill, 1998
3. Richard Crowder, Electrical Drives and Electromechanical systems, Elsevier, 2013
4. Mehta V. K. and R. Mehta, Principles of Electrical and Electronics, S. Chand & Company Ltd., 1996.
5. Theraja B. L. and A. K. Theraja, A Text Book of Electrical Technology, S. Chand & Company Ltd., 2008.
6. Vedam Subrahmaniam, Electric Drives (concepts and applications), Tata McGraw- Hill, 2001

References:

1. H.Partab, Art and Science and Utilisation of electrical energy, Dhanpat Rai and Sons, 1994
2. M. D.Singh, K. B. Khanchandani, Power Electronics, Tata McGraw-Hill, 1998
3. Pillai.S,K A first course on Electric drives, Wiley Eastern Limited, 1998

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	DC Machines-principle of operation-emf equation-types of excitations. Separately excited, shunt and series excited DC generators, compound generators. General idea of armature reaction, OCC and load characteristics - simple numerical problems.	6	15%
II	Principles of DC motors-torque and speed equations-torque speed characteristics- variations of speed, torque and power with motor current. Applications of dc shunt series and compound motors. Principles of starting, losses and efficiency – load test- simple numerical problems.	6	15%
	FIRST INTERNAL EXAMINATION		
III	Transformers – principles of operations – emf equation- vector	7	15%

	diagrams- losses and efficiency – OC and SC tests. Equivalent circuits- efficiency calculations- maximum efficiency – all day efficiency – simple numerical problems. Auto transformers constant voltage transformer- instrument transformers.		
IV	Three phase induction motors- slip ring and squirrel cage types- principles of operation – rotating magnetic field- torque slip characteristics- no load and blocked rotor tests. Circle diagrams- methods of starting – direct online – auto transformer starting	7	15%
SECOND INTERNAL EXAMINATION			
V	Single phase motors- principle of operation of single phase induction motor – split phase motor – capacitor start motor- stepper motor- universal motor Synchronous machines types – emf equation of alternator – regulation of alternator by emf method. Principles of operation of synchronous motors- methods of starting- V curves- synchronous condenser	8	20%
VI	Stepper motors: Principle of operation, multistack variable reluctance motors, single-stack variable reluctance motors, Hybrid stepper motors, Linear stepper motor, comparison, Torque-speed characteristics, control of stepper motors Controllers for automation, servo control, Digital controllers, Advanced control systems, Digital signal processors, motor controllers, Axis controllers, Machine tool controllers, Programmable Logic Controllers	8	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: in all parts each question can have a maximum of four sub questions

Course code	Course Name	L-T-P - Credits	Year of Introduction
HS300	Principles of Management	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To develop ability to critically analyse and evaluate a variety of management practices in the contemporary context;
- To understand and apply a variety of management and organisational theories in practice;
- To be able to mirror existing practices or to generate their own innovative management competencies, required for today's complex and global workplace;
- To be able to critically reflect on ethical theories and social responsibility ideologies to create sustainable organisations.

Syllabus

Definition, roles and functions of a manager, management and its science and art perspectives, management challenges and the concepts like, competitive advantage, entrepreneurship and innovation. Early contributors and their contributions to the field of management. Corporate Social Responsibility. Planning, Organizing, Staffing and HRD functions, Leading and Controlling. Decision making under certainty, uncertainty and risk, creative process and innovation involved in decision making.

Expected outcome.

A student who has undergone this course would be able to

i. manage people and organisations
ii. critically analyse and evaluate management theories and practices
iii. plan and make decisions for organisations
iv. do staffing and related HRD functions

Text Book:

Harold Koontz and Heinz Weihrich, *Essentials of Management*, McGraw Hill Companies, 10th Edition.

References:

1. Daft, *New era Management*, 11th Edition, Cengage Learning
2. Griffin, *Management Principles and Applications*, 10th Edition, Cengage Learning
3. Heinz Weirich, Mark V Cannice and Harold Koontz, *Management: a Global, Innovative and Entrepreneurial Perspective*, McGraw Hill Education, 14th Edition
4. Peter F Drucker, *The Practice of Management*, McGraw Hill, New York
5. Robbins and Coulter, *Management*, 13th Edition, 2016, Pearson Education

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Management: definitions, managerial roles and functions; Science or Art perspectives- External environment-global, innovative and entrepreneurial perspectives of Management (3 Hrs.)– Managing people and organizations in the context of New Era- Managing for competitive advantage - the Challenges of Management (3 Hrs.)	6	15%

II	**Early Contributions and Ethics in Management**: Scientific Management- contributions of Taylor, Gilbreths, Human Relations approach-contributions of Mayo, McGregor's Theory, Ouchi's Theory Z (3 Hrs.) Systems Approach, the Contingency Approach, the Mckinsey 7-S Framework Corporate Social responsibility- Managerial Ethics. (3 Hrs)	6	15%
FIRST INTERNAL EXAMINATION			
III	**Planning:** Nature and importance of planning, -types of plans (3 Hrs.)- Steps in planning, Levels of planning - The Planning Process. – MBO (3 Hrs.).	6	15%
IV	**Organising for decision making:** Nature of organizing, organization levels and span of control in management Organisational design and structure –departmentation, line and staff concepts (3 Hrs.) Limitations of decision making-Evaluation and selecting from alternatives- programmed and non programmed decisions - decision under certainty, uncertainty and risk-creative process and innovation (3 Hrs.)	6	15%
SECOND INTERNAL EXAMINATION			
V	**Staffing and related HRD Functions:** definition, Empowerment, staff – delegation, decentralization and recentralisation of authority – Effective Organizing and culture-responsive organizations –Global and entrepreneurial organizing (3 Hrs.) Manager inventory chart-matching person with the job-system approach to selection (3 Hrs.) Job design-skills and personal characteristics needed in managers-selection process, techniques and instruments (3 Hrs.)	9	20%
VI	**Leading and Controlling:** Leading Vs Managing – Trait approach and Contingency approaches to leadership - Dimensions of Leadership (3 Hrs.) - Leadership Behavior and styles – Transactional and Transformational Leadership (3 Hrs.) Basic control process- control as a feedback system – Feed Forward Control – Requirements for effective control – control techniques – Overall controls and preventive controls – Global controlling (3 Hrs.)	9	20%
END SEMESTER EXAM			

Question Paper Pattern

Max. marks: 100, Time: 3 hours .
The question paper shall consist of three parts

Part A: 4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)
Part B : 4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)
Part C: 6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
**341	DESIGN PROJECT	0-1-2-2	2016

Prerequisite : Nil

Course Objectives

- To understand the engineering aspects of design with reference to simple products
- To foster innovation in design of products, processes or systems
- To develop design that add value to products and solve technical problems

Course Plan

Study : Take minimum three simple products, processes or techniques in the area of specialisation, study, analyse and present them. The analysis shall be focused on functionality, strength, material, manufacture/construction, quality, reliability, aesthetics, ergonomics, safety, maintenance, handling, sustainability, cost etc. whichever are applicable. Each student in the group has to present individually; choosing different products, processes or techniques.

Design: The project team shall identify an innovative product, process or technology and proceed with detailed design. At the end, the team has to document it properly and present and defend it. The design is expected to concentrate on functionality, design for strength is not expected.

Note : The one hour/week allotted for tutorial shall be used for discussions and presentations. The project team (not exceeding four) can be students from different branches, if the design problem is multidisciplinary.

Expected outcome.

The students will be able to

i. Think innovatively on the development of components, products, processes or technologies in the engineering field
ii. Analyse the problem requirements and arrive workable design solutions

Reference:

Michael Luchs, Scott Swan, Abbie Griffin, 2015. Design Thinking. 405 pages, John Wiley & Sons, Inc

Evaluation

First evaluation (Immediately after first internal examination) 20 marks
Second evaluation (Immediately after second internal examination) 20 marks
Final evaluation (Last week of the semester) 60 marks

Note: All the three evaluations are mandatory for course completion and for awarding the final grade.

Course code	Course Name	L-T-P-Credits	Year of Introduction
EE335	ELECTRICAL AND ELECTRONICS LAB	0-0-3-1	2016

Course Objectives: The main objectives of this course are

- To give a practical knowledge on the working of electrical machines including dc machines, induction motors and synchronous motors.
- To impart the basics about design and implementation of small electronic circuits.

Syllabus

List of experiments:

1. OCC on a dc shunt generator, determination of critical resistance, critical speed, additional resistance required in the field circuit
2. Load characteristics of DC Shunt generator
3. Load characteristics of DC Compound generator
4. Load test on DC Series motor
5. Load test on DC Shunt motor
6. Load test on single phase transformer
7. Starting of three phase squirrel cage induction motor by star delta switch, load test on three phase squirrel cage induction motor
8. Load test on three phase slip ring induction motor
9. Load test on single phase induction motor.
10. OC and SC test on single phase transformer
11. V-I Characteristics of diodes and Zener diodes
12. Input and output characteristics of CE configuration of BJT S. Determination of β, input resistance and output resistance.
13. Half wave and full wave rectifiers with and without filters- Observe the waveforms on CRO.

Expected outcome:

The students will be able to

i. Test and validate various types of electrical motors

ii. Acquire knowledge on working of semiconductor devices.

Course code	Course Name	L-T-P - Credits	Year of Introduction
ME331	MANUFACTURING TECHNOLOGY LABORATORY – I	0-0-3-1	2016

Prerequisite: ME220 Manufacturing Technology

Course Objectives:

1. To practice on machine tools and identify, manipulate and control various process parameters during machining processes in manufacturing industry.
2. To practice arc and gas welding technologies.
3. To gain knowledge on the structure, properties, treatment, testing and applications of Steel, Cast Iron and Brass.

List of Exercises/Experiments :

Centre Lathe

Study of lathe tools: - tool materials - selection of tool for different operations - tool nomenclature and attributes of each tool angles on cutting processes – effect of nose radius, side cutting edge angle, end cutting edge angle and feed on surface roughness obtainable – tool grinding.

- Study the different methods used to observe how the work-piece is precisely fixed on lathe.
- Study the **optimum aspect ratio** of work-piece to avoid vibration and wobbling during turning.
- Machine tool **alignment of test** on the lathe.
- **Re-sharpening** of turning tool to specific geometry

1. Exercises on centre lathe:- Facing, plain turning, step turning and parting – groove cutting, knurling and chamfering - form turning and taper turning – eccentric turning, multi-start thread, square thread and internal thread etc.

2. Exercises on lathe: - Measurement of cutting forces in turning process and correlation of the surface roughness obtainable by varying feed, speed and feed.

3. Measurement of **cutting temperature and tool life** in turning and machine tool **alignment test** on lathe machine.

4. Exercises on Drilling machine- drilling, boring, reaming, tapping and counter sinking etc.

5. Exercises on drilling machine: - Measurement of cutting forces in drilling process and correlate with varying input parameters.

6. Exercises on Shaping machine

Exercises on shaping machine: - flat surfaces, grooves and key ways.

7. Exercises on Slotting machine

Exercises on slotting machine: - flat surfaces, grooves and key ways.

Exercises on Milling machine

8. Exercises on milling machine: - face milling, end milling – spur and helical gear cutting – milling of keyways etc.

9. Exercises on milling machine: **-** Measurement of cutting forces in milling process and

correlate the surface roughness obtainable by varying input parameters.

10 Machine tool **alignment test** on milling machine

Planing and Broaching machine

11. Study and demonstration of broaching machine.

12. Exercises on planing machine

Exercises on Welding

13. Exercises on arc and gas welding: - butt welding and lap welding of M.S. sheets.

Exercises on Grinding machine

14. Exercise on surface grinding, cylindrical grinding and tool grinding etc.

15. Measurement of cutting forces and roughness in grinding process and correlate with varying input parameters.

Metallurgy

16. Specimen preparation, etching & microscopic study of Steel, Cast iron and Brass and Grain size measurement.

17. Heat treatment study:–Effect on mechanical properties and microstructure of Steel, Cast Iron and Brass.

18. Studies of various quenching mediums, **Carryout heat treatments on steel** based on ASM handbook vol.4 and observe the hardness obtained.

A minimum of 12 experiments are mandatory out of total 18 experiments but all the experiments mentioned in metallurgy are mandatory.

Besides to the skill development in performing the work, oral examination should be conducted during end semester examination.

The student's assessment, continuous evaluation, awarding of sessional marks, oral examination etc. should be carried out by the assistant professor or above.

Expected outcomes:

The students will be able to

1. Identify various process parameters and their influence on surface properties of various metals.
2. Recommend appropriate speed, feed and depth of cut for various processes on lathe machine.
3. Position, hold and locate work material and cutting tools in various basic machine tools.
4. Choose suitable welding process for different metals.
5. Choose appropriate heat treatment process for different metals

Text Books:

1. Acharkan. N., Machine Tool Design Vol. 1 to 4, MIR Publication, 2000.
2. HMT, Production Technology, Tata McGraw Hill, 2001
3. W. A. J. Chapman, Workshop Technology Part I, ELBS & Edward Arnold Publishers, 1956

SYLLABUS

Elective 1

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME361	Advanced Fluid Mechanics	3-0-0-3	2016

Prerequisite : ME203 Mechanics of fluids

Course Objectives: The main objectives of this course are to

- To provide knowledge regarding fluid-flow phenomena observed in mechanical engineering systems, such as potential flow, vortex flow, boundary-layer flows, etc.
- To undertake sustained learning in fluid mechanics to advance their knowledge in this field.
- To enhance the understanding of fluid mechanics, including the equations of motion in differential form and turbulence.

Syllabus

Basic Concepts and Fundamentals, Stream function and Potential function, Lagrangian and Eulerian approaches, Potential flow, Incompressible viscous flow, Boundary layer theory, Turbulent Flow.

Expected Outcome:

The students will be able to

i. Recognize the particular flow regime present in typical engineering system.
ii. Demonstrate the concept of stream function, potential function and boundary layer.
iii. Calculate the vorticity of a given velocity field and analyze the vorticity in idealized vortices: forced vortex and free vortex.
iv. Choose the appropriate fluid mechanics principles needed to analyze the fluid-flow situations.
v. Recognize how fluid flow theory can be employed in a modern mechanical engineering design environment.

Text books

1. Bansal R. K., A Text Book of Fluid Mechanics and Machines, Laxmi Publications, 2010.
2. Douglas J. F., Fluid Mechanics, Pearson Education, 2005.
3. Kumar D. S., Fluid Mechanics and Fluid Power Engineering, S. K. Kataria & Sons, 1987.
4. Muralidhar K., G. Biswas, Advanced Engineering Fluid Mechanics, Alpha Science International limited, 2005.
5. Rama D. D., Fluid Mechanics and Machines, New Age International, 2009.

Reference books

1. Schlichting H., K. Gersten , Boundary Layer Theory, 8/e, Springer 2000.
2. Shames I. H., Mechanics of Fluids, 4/e, McGraw-Hill, 2002.
3. Streeter V. L. and E. B. Wylie, Fluid Mechanics, McGraw-Hill, 1979.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks

I	Basic Concepts and Fundamentals: Fluid statics, Cartesian Tensors, Fluid Kinematics, and Description of fluid motion – Types of motion of fluid elements, Vorticity and circulation – Concept of rotational and irrotational flows. Equation of motion of forced and free vortex flow. Stream function and Potential function. Stream function and its relation with velocity field. Relation between stream function and stream lines - Relation between stream function and velocity potential for a 2-D irrotational and incompressible flow.	**7**	**15%**
II	Relation between stream lines and lines of constant potential. Sketching of stream lines. Lagrangian and Eulerian approaches, acceleration, temporal acceleration, convective acceleration. Reynolds transport theorem, derivation of continuity and momentum equations using Reynolds transport theorem. Problems on the application of momentum equation	**6**	**15%**
FIRST INTERNAL EXAMINATION			
III	Potential flow: Uniform flow, source flow, sink flow, free vortex flow and super imposed flow-source and sink pair, doublet, plane source in a uniform flow(flow past a half body), source and sink pair in a uniform flow(flow past a Rankine oval body), doublet in a uniform flow(flow past a circular cylinder). Pressure distribution on the surface of the cylinder. Flow past a cylinder with circulation, Kutta-Juokowsky's law. Complex flow potential, complex flow potentials for source, sink, vortex and doublet. Potential flow between two parallel plates, potential flow in a sector. Introduction to conformal transformation, conformal mapping.	**7**	**15%**
IV	Incompressible viscous flow. Concepts of laminar and turbulent flows . Stokes viscosity law. Navier Stoke's equation and significance (Derivation not necessary).Simplification of Havier stock equation for steady incompressible flows with negligible body forces. Parallel flow through straight channel and couette flow. Hagen - Poiseuille flow. Derivation of Hagen Poissuille equations for velocity and discharge through a pipe, derivation of friction factor for laminar flow, Couette flow for negative, zero and positive pressure gradients, flow in a rotating annulus, Viscometer based on rotating annulus.	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Boundary layer theory, Boundary layer thickness, Displacement thickness, momentum thickness, Energy thickness and their calculation. Laminar Boundary Layers, Boundary layer equations; Boundary layer on a flat plate, Prandtl boundary layer equations, Blasius solution for flow over a flat plate, Von- Karman momentum integral	**8**	**20%**

	equations, Pohlhausen approximation solution of boundary layer for non-zero pressure gradient flow, favorable and adverse pressure gradients, Entry flow into a duct, flow separation and vortex shedding.		
V1	Turbulent Flow: Introduction to turbulent flow, Governing equations of turbulent flow, Turbulent boundary layer equation, Flat plate turbulent boundary layer, Fully developed Turbulent pipe flow for moderate Reynold's number, Prandtl mixing hypothesis, Turbulence modeling. Boundary layer control.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME363	COMPOSITE MATERIALS AND MECHANICS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

1. To understand various matrices and reinforcements used in composites
2. To know about polymer matrix composites, metal matrix composites, ceramic matrix composites and its manufacturing and applications
3. To introduce post processing operations and micromechanics of composites

Syllabus

Composites – Reinforcements – Matrices – Polymer matrix composite – Metal matrix composite – Ceramic matrix composite – Post processing operations – Micromechanics of composites

Expected outcome:

- The students will be able to gain knowledge about composites, reinforcements, matrices, post

Text Books:

1. K. K. Chawla, Composite Materials : Science and Engineering, Springer, 3e, 2013.
2. Reddy J N (Ed.), Mechanics of Composite Materials; Selected Works of Nicholas J. Pagano, Springer, 1994
3. Robert M. Jones, Mechanics of Composite Materials, CRC Press, 1998

References Books:

1. F.L.Matthews & R.D.Rawlings, Composite Materials, Engineering and Sciences, Chapman & hall, London, 1994
2. Hand Book of Composites, George Lubin. Van Nostrand, Reinhold Co. 1982
3. Micael hyer, Stress Analysis of Fiber - Reinforced Composite Materials , Tata McGraw Hill, 1998.
4. P.K.Mallicak, Fiber-reinforced composites , Monal Deklar Inc., New York, 1988.
5. Ronald Gibson, Principles of Composite Material Mechanics , TMH, 1994.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Composite : Introduction, definition, characteristics, functions	1	15%
	classification of composites based on structure and matrix	1	
	smart composites, advantages and limitations	1	
	history, industrial scene and applications	1	
	Interfaces: wettability and bonding interface in composites	1	

	types of bonding at interface.	**1**	
II	Fibers : Introduction, types of fibers, natural fibers	**1**	**15%**
	glass fiber fabrication, structure, properties and applications	**2**	
	boron fiber fabrication, structure, properties and applications	**1**	
	carbon fiber, Ex-Pan carbon fiber	**1**	
	Ex cellulose carbon fiber, Ex-Pitch carbon	**1**	
	carbon fiber structure, properties and applications	**1**	
	aramid fiber fabrication, structure, properties and applications	**1**	
	whiskers: characteristics, properties and applications.	**1**	
	FIRST INTERNAL EXAMINATION		
III	Polymer matrix composites (PMC) : thermoset, thermoplastic and elastomeric polymers	**1**	**15%**
	properties, characteristics and applications as matrix materials	**1**	
	processing of polymer matrix composites: hand methods, Lay up method, spray up method	**2**	
	moulding methods, pressure bagging and bag moulding methods,	**1**	
	pultrusion and filament winding process.	**1**	
IV	Metal matrix composites (MMC) : classification of metals, intermetallics, alloys and their potential role as matrices in composites	**1**	**15%**
	properties, characteristics and applications of metals as matrix materials	**1**	
	production techniques: powder metallurgy, diffusion bonding, melt stirring	**2**	
	squeeze casting, liquid infiltration under pressure, spray code position, insitu process.	**2**	
	SECOND INTERNAL EXAMINATION		
V	Ceramic matrix composites (CMC) : classification of ceramics and their potential role as matrices,	**1**	**20%**
	properties, characteristics and applications of ceramics as matrix materials	**1**	
	conventional techniques : cold pressing and sintering, hot pressing, reaction bonding,	**1**	
	hot pressing and reaction bonding new techniques : liquid infiltration, pultrusion,	**1**	
	lanxide process, insitu chemical technique, sol-gel technique	**2**	

V1	Post processing operations : machining, cutting, polishing,	**1**	**20%**
	welding, rivetting and painting	**1**	
	Advanced post processing methods : ultrasonic welding, plasma coating,	**1**	
	Water jet cutting and laser machining	**1**	
	Micromechanics of composites: maximum stress and strain criterion (derivations)	**2**	
	Tsai-Hill and Tsai-Wu failure criterion (derivations)	**2**	
	mechanics of load transfer from matrix to fiber (description)	**1**	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME365	Advanced Metal Casting	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To gain theoretical and practical knowledge in material casting processes
- To develops an understanding of the dependent and independent variables which control materials casting in a production processes.
- To impart knowledge on design of gating system for castings
- To know foundry practice of ferrous and non ferrous alloys

Syllabus

Functional requirements of molding materials, gating - type of gating- gating design- factor involved in gating design, risers – primary function of a riser-theoretical consideration-riser design and placement, solidification, heat transfer during solidification, heat flow in solidification, ferrous and non-ferrous foundry practice, steel casting, aluminum and its alloys, magnesium and its alloys, casting design, defects and testing.

Expected outcome:

- The students will have exposed to the different areas of foundry practices, gained idea about metal casting, scope and its applications.

Text Books/References

1. A.K.Chakrabarti, Casting Technology and Cast Alloys, Prentice –Hall Of India Ltd, 2005
2. Beely, Foundry Technology, Newnes-Butterworths, 1979
3. Gruzleski, The Treatment of Liquid Aluminum-Silicon Alloys, the American Foundrymen's Society Inc, USA, 1992
4. Heine, Loper and Rosenthal, Principle of Metal Casting, 2nd Edition, Tata Mc-Graw-Hill Publishing Company Limited, New Delhi, 1978
5. John Cambell, Casting, Butterworth-Heineman Ltd, Jordon Hill, Oxford, 1991
6. T.V.Rama Rao, Metal casting Principles and Practice, New Age International,2010
7. Gruzleski, The Treatment of Liquid Aluminum-Silicon Alloys, the American Foundrymen's Society Inc, USA, 1992.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	**Design of molds** Functional requirements of molding materials, type of sands Properties of molding sand, sand testing techniques Effect of molding on sand properties,	2	15%

	Bonding material	**1**	
	Mould surface coating	**1**	
	Sand design and control	**1**	
	Thermal aspect of molding sand, mould wall movement	**1**	
II	**Pouring and feeding** **Gating -** type of gating- gating design	**1**	**15%**
	Factor involved in gating design-illustrative problems in determination of filling time and discharge rate	**1**	
	Aspiration effect- effects of friction and velocity distribution	**1**	
	Risers – primary function of a riser Theoretical consideration Riser design and placement Determination of dimensions of rise- blind risers	**2**	
	Internal risers-use of chills Use of insulators and exothermic compounds	**1**	
FIRST INTERNAL EXAMINATION			
III	**Solidification**		**15%**
	Freezing of pure metal Skin effects- nucleation and growth	**1**	
	Shrinkage- freezing of alloys	**1**	
	Effect of mould materials and alloy composition on casting	**1**	
	Fluidity- factor affecting fluidity- fluidity measurement and application of fluidity	**1**	
	Gases in metals- degassing	**1**	
	Grain refinement	**1**	
	Illustrative problems related to determination of solidification time	**1**	
IV	**Heat transfer during solidification**		**15%**
	Methods of manipulating heat transfer	**1**	
	Experimental methods for the study of heat transfer during solidification		
	Crystal growth methods	**1**	
	Heat flow in solidification	**1**	
	Heat transfer with in the solid/liquid metal system	**1**	
	Heat transfer at the metal-mould interface	**1**	
	Heat flow in one dimensional solidification geometries	**1**	
	Freezing at mould wall	**1**	
	Rapid freezing in contact with a cold substrate with initial melt super cooling	**1**	
SECOND INTERNAL EXAMINATION			
V	**Ferrous and non ferrous castings** **Steel Casting** – The family of cast iron	**1**	**20%**
	Melting of steels and cast irons–Grey iron Foundry practice – ductile iron – Malleable Iron casting	**1**	

	design		
	Aluminum and its alloys: Different Aluminum alloy systems Advantage and limitation of Aluminum alloy castings	**1**	
	Molding for aluminum castings - melting of Aluminum- degassing- grain refinement	**1**	
	Modification- effect of various melt treatment on the mechanical properties of Aluminum castings.	**1**	
	Magnesium and its alloys: different alloy systems- advantage and limitation of Magnesium alloy castings Molding for magnesium casting- melting of Magnesium- flux and flux less melting	**1**	
	Type and functions of fluxes used- degassing and grain refinement- pouring technique	**1**	
	Copper alloys: advantage of Copper alloys- melting- drossing-oxygen and hydrogen in Copper melting- control of gases- de oxidation	**1**	
V1	**Casting defects and testing**		**20%**
	Functional design- metallurgical design	**1**	
	simplification of foundry practice- economic considerations	**1**	
	design of junction- specification of castings	**1**	
	inspection of castings- analysis of casting defects	**1**	
	nondestructive testing of casting- dye penetrant testing	**1**	
	magnetic flaw detection, radiography, ultrasonic testing, etc.	**1**	
	quality control and quality assurance	**1**	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

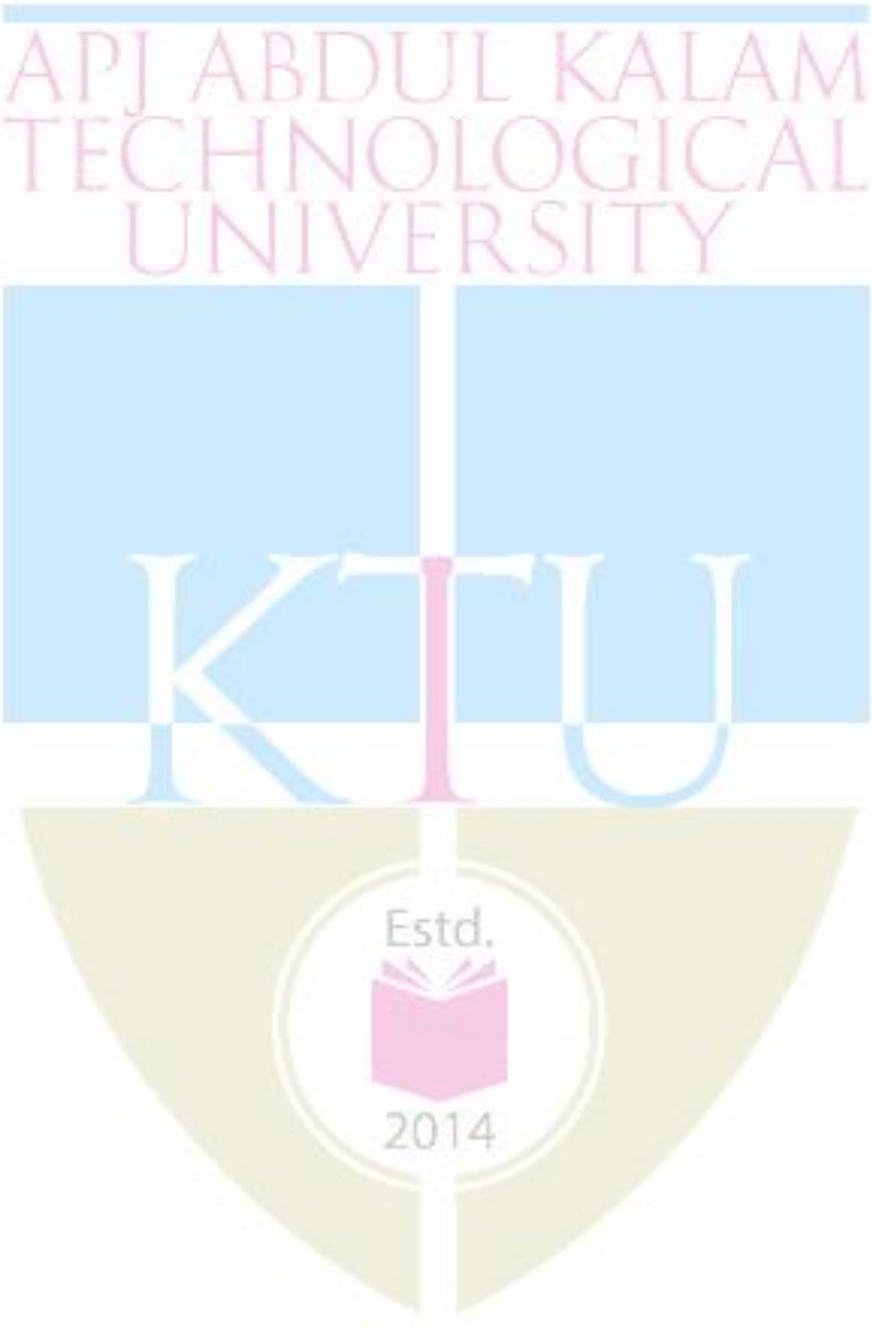
Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.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Course code	Course Name	L-T-P-Credits	Year of Introduction
ME367	Non-Destructive Testing	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To introduce the basic principles, techniques, equipment, applications and limitations of NDT methods such as Visual, Penetrant Testing, Magnetic Particle Testing, Ultrasonic Testing, Radiography, Eddy Current.
- To enable selection of appropriate NDT methods.
- To identify advantages and limitations of nondestructive testing methods
- To make aware the developments and future trends in NDT.

Syllabus

Introduction to NDT- Visual Inspection- Liquid Penetrant Inspection- Magnetic Particle Inspection- Ultrasonic Testing- Radiography Testing- Eddy Current Testing.

Expected outcome

- The students will be able to differentiate various defect types and select the appropriate NDT methods for the specimen.

Text book

- Baldev Raj, Practical Non – Destructive Testing, Narosa Publishing House ,1997

Reference books

1. Hull B. and V.John, Non-Destructive Testing, Macmillan,1988
2. Krautkramer, Josef and Hebert Krautkramer, Ultrasonic Testing of Materials, Springer-Verlag, 1990

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to NDT, Comparison between destructive and NDT, Importance of NDT, Scope of NDT, difficulties of NDT, future progress in NDT, economics aspects of NDT.	1 1	15%
	Visual Inspection - tools, applications and limitations - Fundamentals of visual testing: vision, lighting, material attributes, environmental factors.	1 1	
	visual perception, direct and indirect methods mirrors, magnifiers, boroscopes, fibroscopes, closed circuit television, light sources	1 1	
	special lighting, a systems, computer enhanced system	1	
II	**Liquid Penetrant Inspection**: principles, properties required for a good penetrants and developers - Types of penetrants and developers	1 1	15%
	and advantages and limitations of various methods of LPI - LPI technique/ test procedure	1 1	
	interpretation and evaluation of penetrant test indications, false indication	1 1	

	and safety precaution required in LPI, applications, advantages and limitations	**1**	
FIRST INTERNAL EXAMINATION			
III	**Magnetic Particle Inspection (MPI)-** Principles of MPI, basic physics of magnetism, permeability, flux density, cohesive force, magnetizing force, rentivity, residual magnetism	**1** **1**	**15%**
	Methods of magnetization, magnetization techniques such as head shot technique, cold shot technique, central conductor testing, magnetization using products using yokes	**1** **1**	
	direct and indirect method of magnetization, continuous testing of MPI, residual technique of MPI, system sensitivity, checking devices in MPI	**1** **1**	
	Interpretation of MPI, indications, advantage and limitation of MPI.	**1**	
IV	**Ultrasonic Testing (UT):** principle, types of waves, frequency, velocity, wavelength, reflection, divergence, attenuation, mode conversion in ultrasonic UT testing methods	**1** **1**	**15%**
	contact testing and immersion testing, normal beam and straight beam testing, angle beam testing, dual crystal probe, ultrasonic testing techniques	**1** **1**	
	resonance testing, through transmission technique, pulse echo testing technique, instruments used UT, accessories such as transducers, types, frequencies, and sizes commonly used	**1** **1**	
	Reference blocks with artificially created defects, calibration of equipment, Applications, advantages, limitations, A, B and C scan - Time of Flight Diffraction (TOFD).	**1**	
SECOND INTERNAL EXAMINATION			
V	**Radiography Testing (RT):** Principle, electromagnetic radiation sources: X-ray source, production of X-rays, high energy X-ray source, gamma ray source - Properties of X-rays and gamma rays	**1** **1**	**20%**
	Inspection techniques like SWSI, DWSI, DWDI, panoramic exposure, real time radiography, films used in industrial radiography, types of film, speed of films, qualities of film	**1** **1**	
	screens used in radiography, quality of a good radiograph, film processing, interpretation, evaluation of test results, safety aspects required in radiography	**1** **1**	
	applications, advantages and limitations of RT	**1**	
V1	**Eddy Current Testing (ECT)** - Principle, physics aspects of ECT like conductivity, permeability, resistivity, inductance, inductive reactance, impedance	**1** **1**	**20%**
	Field factor and lift of effect, edge effect, end effect, impedance plane diagram in brief, depth of penetration of ECT, relation between frequency and depth of penetration in ECT	**1** **1**	
	equipments and accessories, various application of ECT such as	**1**	

	conductivity measurement, hardness measurement, defect detection	**1**	
	coating thickness measurement, advantages and limitations of eddy current testing	**1**	
END SEMESTER UNIVERSITY EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME369	Tribology	3-0-0-3	2016
Prerequisite : Nil			

Course Objectives

- To provide broad based understanding of the subject 'Tribology' and its technological significance
- To understand the genesis of friction, the theories/laws of sliding and rolling friction and the effect of viscosity
- To learn about consequences of wear, wear mechanisms, wear theories and analysis of wear problems
- To learn about the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques and the application of lubrications in metal working.
- To understand the importance of adhesion property in different applications and to get knowledge about different bearing materials.
- To understand the nature of engineering surfaces, their topography and learn about surface characterization techniques

Syllabus

Introduction to Tribology- Tribology in Design, Tribology in Industry, Tribological Parameters Like Friction, Wear and Lubrication, different types of lubrication techniques and applications, measurement of friction and wear -The Topography of Engineering Surface, Contact Between Surfaces, surface modification techniques- Adhesion properties, Adhesion in Magnetic Recording Systems, Types of Bearings, Comparison of Sliding and Rolling Contact Bearings.

Expected Outcome

The students will be able to

i. Understand the subject 'tribology' and its technological significance.
ii. Understanding the theories/laws of sliding and rolling friction and the effect of viscosity.
iii. Get basic idea on consequences of wear, wear mechanisms, wear theories and analysis of wear problems
iv. Get an exposure to theories of hydrodynamic and the advanced lubrication techniques and the application of lubrications in metal working.
v. Gain overview of adhesion property in different applications and to get knowledge about different bearing materials
vi. Get basic idea about the nature of engineering surfaces, their topography and learn about surface characterization techniques.

Text books

1. Ernest Rabinowicz, Friction and Wear of Materials, John Wiley & sons,1995
2. I.M. Hutchings, Tribology: Friction and Wear of Engineering Materials, Butterworth-Heinemann,1992
3. Prasanta Sahoo, Engineering Tribology, PHI Learning Private Ltd, New Delhi, 2011.

Reference books

1. B. Bhushan, Introduction to Tribology, John Wiley & Sons, Inc, New York, 2002
2. B.Bhushan, B.K. Gupta, Handbook of tribology: materials, coatings and surface treatments", McGraw-Hill,1997
3. Halling J ,"Principles of Tribology", McMillan Press Ltd.,1978

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to Tribology- Tribology in Design, Tribology in Industry, Economic Aspects of Tribology	1	15%
	Tribological Parameters Like Friction, Wear and Lubrication	1	
	The Topography of Engineering Surface, Contact Between Surfaces.	2	
	Types of Bearings, Comparison of Sliding and Rolling Contact Bearings.	2	
II	Introduction, Empirical Laws of Friction, Kinds of Friction	1	15%
	Causes of Friction, Theories of Friction	1	
	Measurement of Friction	1	
	Friction of Metals, Ceramic Materials, Polymers.	2	
	Rolling Friction- Laws of Rolling Friction, Relation Between Temperature and Friction	1	
	Stick-Slip, Prevention of Stick-Slip, Consequences of Friction.	1	
FIRST INTERNAL EXAMINATION			
III	Types of Wear, Various Factors Affecting Wear	1	15%
	Theories of Wear, Wear Mechanisms	2	
	Measurement of Wear.	1	
	Wear Regime Maps, Alternative Form of Wear Equations	1	
	Lubricated and Unlubricated Wear of Metals, Materials Used in Different Wear Situations.	2	
IV	Fundamentals of Viscosity And Viscous Flow	1	15%
	Principle and Application of; Hydrodynamic Lubrication, Elastrodynamic Lubrication, Boundary and Solid Lubrication	2	
	Types of Lubricants, Properties of Lubricants	1	
	Effect of Speed and Load on Lubrication, Frictional Polymers.	1	
	Lubrication in Metal Working: Rolling, Forging, Drawing and Extrusion.	2	
SECOND INTERNAL EXAMINATION			
V	**Adhesion:** Introduction, Adhesion Effect by Surface Tension, Purely Normal Contact and Compression Plus Shear	2	20%

	Adhesion in Magnetic Recording Systems	**1**	
	Dependence of Adhesion on Material and Geometric Properties.	**1**	
	Bearing Materials: Introduction, Rolling Bearing, Fluid Film Lubricated Bearing, Dry Bearing, Bearing Constructions.	**3**	
V1	Introduction To Surface Engineering, Concept and Scope of Surface Engineering.	**1**	**20%**
	Surface Modification – Transformation Hardening, Surface Melting, Thermo chemical Processes	**3**	
	Surface Coating – Plating and Anoding Processes, Fusion Processes, Vapor Phase Processes.	**3**	
	Selection of Coating For Wear And Corrosion Resistance, Potential Properties and Parameters of Coating.	**1**	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME371	Nuclear Engineering	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To explore the engineering design of nuclear power plants using the basic principles of reactor physics, thermodynamics, fluid flow and heat transfer.
- To provide an overview on reactor principles, nuclear safety, and reactor dynamic behaviour.
- To understand the standards of radiation protection and need for nuclear waste disposal

Syllabus

Review of Elementary nuclear physics, Nuclear fission, Boiling water reactor, Structural materials, Nuclear fuels, Reactor heat removal, Safety and disposal

Expected Outcome:

The students will be able to

1. understand the theories and principles of nuclear power generation
2. understand the heat removal techniques applied to reactor heat transfer systems.
3. acquire knowledge about safe disposal of nuclear wastes

Text books/ Reference books

1. S. Glasstone and A. Sesonske, *Nuclear Reactor Engineering*, D. Van Nostrand Company, INC. 1967.
2. S Glasstone, Source book on atomic energy, Krieger Pub Co., 1979

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Review of Elementary nuclear physics: Atomic structure – nuclear energy and nuclear forces – Nuclear fission. Nuclear reactions and radiations – Principles of radioactive decay interactions of an ray with matter – Neutron cross sections and reactions –The fission process – Chain reactions	7	15%
II	Basic principles of controlled fusion .Nuclear reactor principles – Reactor classification – Critical size. Basic diffusion theory - Slowing down of neutrons – Neutrons – Neutron flux and power – Four factor formula – Criticality condition – Basic features of reactor control .	7	15%
	FIRST INTERNAL EXAMINATION		

III	Boiling water reactor . Description of reactor system – Main components –Control and safety features .Materials of reactor construction – Fuel , moderator , coolant	**7**	**15%**
IV	Structural materials – Cladding –Radiation damage, Nuclear fuels : Metallurgy of Uranium – General principles of solvent extraction – Reprocessing of irradiated fuel – Separation process fuel enrichment .	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Reactor heat removal / equations of heat transfer as applied to reactor cooling– Reactor heat transfer systems – Heat removed in fast reactors. Radiation safety : Reactor shielding – Radiation dozes – Standards of radiation protection	**7**	**20%**
V1	Safety and disposal: Nuclear plant safety-safety systems-changes and consequences of accident-criteria for safety-nuclear waste-types of waste and its disposal-radiation hazards and their prevention-weapons proliferation	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

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Course code.	Course Name	L-T-P - Credits	Year of Introduction
ME373	Human Relations Management	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To impart basic idea about human behavior as an individual and relations in group levels.
- To give idea on management of human relations in organizations and collective bargaining.
- To create knowledge on management of employer-employee relations and human conflicts.

Syllabus

Human behaviour as individual, Human behaviour in group, Management of human relations in organisations, Management of human relations and collective bargaining, Managing employer-employee relations, Managing human conflicts, Managing global human relations. Employee safety and health.

Expected outcome

The students will

i. get basic idea about human behavior in individual and group levels.
ii. understand the human relations in organizations and collective bargaining.
iii. be able to manage employer-employee relations and conflicts.

Text Books:

1. Gary Dessler, Human Resource Management., Pearson Education, 2017
2. Seema Sanghi , Stephen P. Robbins, , Timoti A Judge : Organizational Behaviour, Pearson Education, 2009

References:

1. Aubrey. C. Sanford, Human Relations: Theory and Practice, Merrill, 1973
2. C S Venkata Ratnam and B K Srivastava, Personnel Management and Human Resources, TMH, 1996.
3. William Scott, R C Clothier and W Spiegel : Personnel Management Principles: Practices and Points of Views, Tata Mc Graw Hill, 1977.
4. Uma Sekharan, Organizational Behaviour-Text and Cases ,Tata Mc Graw Hill, 1989.
5. V. Kumar, Customer Relationship Management, Wiley India Edition, 2013.

Course Plan

Module		Hours	End Sem. Exam Marks
I	**Human Behaviour**: Biological characteristics, age, gender, tenure. Ability, intellectual and physical abilities. Learning, theories of learning. Values, importance of values, types. Attitudes, types, attitudes and consistency, workforce diversity. Personality and emotions, personality determinants and traits, emotion dimensions. Perception, factors influencing perception, making judgement about others, link between perception and individual decision making.	6	15%
II	**Human Behaviour and Relations in Groups**: Defining and classifying different groups. Stages of group development, Five stage model. Group structure, roles, norms, status and size. Group decision making, group versus the individual. Types of teams, self-managed work teams, problem solving teams. Creating effective teams, composition, work design, process and team players.	6	15%
FIRST INTERNAL EXAMINATION			

III	**Management of Human Relations in Organisations**: Ethics and fair treatment at work, ethics and the law, ethics fair treatment and justice. Ethical behaviour at work, individual factors, organizational factors, the boss's influence, ethics policies and codes, the organization's culture, role of HR in fostering ethics and fair treatment. Disciplining an employee, formal disciplinary appeals process, discipline without punishment, employee privacy.	7	15%
IV	**Management of Human Laws and Collective Bargaining**: Employment law, gross misconduct, personal supervisory liability, layoffs and the plant closing law. Collective bargaining, good faith, negotiating team, bargaining items, bargaining stages, bargaining hints, impasses, mediation, and strikes, the contract agreement. Grievances, sources of grievances, the grievance procedure, guidelines for handling grievances.	7	15%
SECOND INTERNAL EXAMINATION			
V	**Management of Training and Employer-Employee Relations**: Training and development, objectives, strategies, methods and techniques. Design and organisation of training and evaluation of training. Employee relations, management-employee relations, managing discipline, grievance and stress, counselling, are handling problem employees. Industrial relations implications of personnel policies, nature of employment relationship.	8	20%
VI	**Management of Human Conflicts, Customer Relations, Unions and Global Relations:** Industrial and organisational conflict, managing for good industrial relations and managing the moment of conflict. Customer relationship management, what if customer is the problem. Place of unions in organizations. The future scenario, the changing personnel management scenario. Managing global human relations. HRD the development role of personnel to the force. Employee safety and health.	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs.**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3x10 marks = 30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3x10 marks = 30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4x10 marks = 40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

SYLLABUS

SEMESTER 6

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME302	Heat and Mass Transfer	3-1-0-4	2016

Prerequisites : ME203 Mechanics of fluid

Course Objectives:

- To introduce the various modes of heat transfer and to develop methodologies for solving a wide variety of practical heat transfer problems
- To provide useful information concerning the performance and design of simple heat transfer systems
- To introduce mass transfer

Syllabus:

Modes of Heat Transfer: Conduction: Most general heat conduction equation, One dimensional steady state conduction with and without heat generation, Critical radius of insulation, Elementary ideas of hydrodynamics and thermal boundary layers, Convection heat transfer: Newton's law of cooling, Dimensionless numbers, Dimensional analysis, Problems. Fins: Types of fins : Fin efficiency and effectiveness. Boiling and condensation heat transfer, Introduction to heat pipe. Transient heat conduction. Heat exchangers, LMTD and NTU methods. Radiation: laws of radiation, Electrical analogy, Radiation shields. Mass Transfer :Mass transfer by molecular diffusion, Convective mass transfer.

Expected outcome:

The students will be able to

1. Apply principles of heat and mass transfer to engineering problems
2. Analyse and obtain solutions to problems involving various modes of heat transfer
3. Design heat transfer systems such as heat exchangers, fins, radiation shields etc..

Text Books:

1. Sachdeva R C, Fundamentals of Engineering Heat and Mass Transfer, New Age Science Limited, 2009
2. R.K.Rajput. Heat and mass transfer, S.Chand& Co.,2015
3. Nag P K., Heat and Mass Transfer, McGraw Hill,2011
4. Kothandaraman, C.P., Fundamentals of Heat and Mass Transfer, New Age International, New Delhi, 2006

Data Book:

- Heat and Mass Transfer data book: C.P. Kothandaraman, S. Subramanya, New age International publishers,2014

References Books:

1. Yunus A Cengel, Heat Transfer: A Practical Approach, McGraw Hill,2015
2. Holman J P, Heat Transfer, McGraw Hill, 2011
3. Frank P. Incropera and David P. Dewitt, Heat and Mass Transfer, John Wiley and sons, 2011

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Modes of Heat Transfer: Conduction: Fourier law of heat conduction-Thermal conductivity of solids, liquids and gases-Factors affecting thermal conductivity- Most general heat conduction equation in Cartesian, cylindrical and spherical coordinates One dimensional steady state conduction with and without heat generation conduction through plane walls, cylinders and spheres-variable thermal conductivity conduction shape factor- heat transfer through corners and edges. Critical radius of insulation.	12	15%
II	Elementary ideas of hydrodynamics and thermal boundary layers-Thickness of Boundary layer-Displacement, Momentum and Energy thickness (description only). Convection heat transfer: Newton's law of cooling- Laminar and Turbulent flow, Reynolds Number, Critical Reynolds Number, Prandtl Number, Nusselt Number, Grashoff Number and Rayleigh's Number. Dimensional analysis Buckingham's Pi theorem- Application of dimensional analysis to free and forced convection- empirical relations- problems using empirical relations	10	15%
FIRST INTERNAL EXAMINATIONEXAM			
III	Transient heat conduction-lumped heat capacity method. Fins: Types of fins - Heat transfer from fins of uniform cross sectional area- Fin efficiency and effectiveness. Boiling and condensation heat transfer(elementary ideas only),Introduction to heat pipe.	8	15%
IV	Combined conduction and convection heat transfer-Overall heat transfer coefficient - Heat exchangers: Types of heat exchangers, AMTD, Fouling factor, Analysis of Heat exchangers- LMTD method, Correction factor, Effectiveness-NTU method, Special type of heat exchangers (condenser and evaporator, simple problems only)	8	15%
SECOND INTERNAL EXAMINATION			
V	Radiation- Nature of thermal radiation-definitions and concepts- monochromatic and total emissive power-Intensity of radiation- solid angle- absorptivity, reflectivity and transmissivity-Concept of black body- Planck' law- Kirchoff's law- Wein's displacement law-Stefan Boltzmann's law- black, gray and real surfaces-Configuration factor (derivation for simple geometries only)- Electrical analogy- Heat exchange between black/gray surfaces- infinite parallel plates, equal and parallel opposite plates-perpendicular rectangles having common edge- parallel discs (simple problems using charts and tables). Radiation shields(no derivation).	10	20%

VI	Mass Transfer :Mass transfer by molecular diffusion- Fick's law of diffusion- diffusion coefficient Steady state diffusion of gases and liquids through solid- equimolar diffusion, Isothermal evaporation of water through air- simple problems. Convective mass transfer- Evaluation of mass transfer coefficient- empirical relations- simple problems- analogy between heat and mass transfer.	8	20%
END SEMESTER EXAM			

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Question Paper Pattern

Use of approved data book permitted

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

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Course code	Course Name	L-T-P-Credits	Year of Introduction
ME304	DYNAMICS OF MACHINERY	2-1-0-3	2016

Prerequisite: ME301 Mechanics of Machinery

Course Objectives:

- To impart knowledge on force analysis of machinery, balancing of rotating and reciprocating masses, Gyroscopes, Energy fluctuation in Machines.
- To introduce the fundamentals in vibration, vibration analysis of single degree of freedom systems.
- To understand the physical significance and design of vibration systems with desired conditions

Syllabus

Force analysis of machinery - static and dynamic force analysis of plane motion mechanisms. Flywheel analysis - static and dynamic balancing - balancing of rotating masses, gyroscopic couples. Vibrations – free vibrations of single degree freedom systems, damping, forced vibration, torsional vibration.

Expected outcome:

The students will be able to

1. Develop the design and practical problem solving skills in the area of mechanisms
2. Understand the basics of vibration and apply the concepts in design problems of mechanisms.

Text Books:

1. Ballaney P.L. Theory of Machines, Khanna Publishers,1994
2. S. S. Rattan, Theory of Machines, Tata McGraw Hill, 2009
3. V. P. Singh, Theory of Machines, Dhanpat Rai,2013

References :

1. E. Wilson, P. Sadler, Kinematics and Dynamics of Machinery, Pearson Education, 2003
2. Ghosh, A. K. Malik, Theory of Mechanisms and Machines, Affiliated East West Press, 2003
3. H. Myskza, Machines and Mechanisms Applied Kinematic Analysis, Pearson Education, 4e, 2012
4. Holowenko, Dynamics of Machinery, John Wiley, 1995
5. J. E. Shigley, J. J. Uicker, Theory of Machines and Mechanisms, McGraw Hill,1995
6. W.T.Thompson, Theory of vibration, Prentice Hall,1997

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Introduction to force analysis in mechanisms - static force analysis (four bar linkages only) - graphical methods	4	15%
	Matrix methods - method of virtual work - analysis with sliding and pin friction	3	
II	Dynamic force analysis: Inertia force and inertia torque. D'Alemberts principle, analysis of mechanisms (four bar linkages only), equivalent dynamical systems	4	15%
	Force Analysis of spur- helical - bevel and worm gearing	3	
FIRST INTERNAL EXAM			
III	Flywheel analysis - balancing - static and dynamic balancing - balancing of masses rotating in several planes	4	15%
	Balancing of reciprocating masses - balancing of multi-cylinder in line engines - V engines - balancing of machines	3	
IV	Gyroscope – gyroscopic couples	3	15%
	Gyroscopic action on vehicles-two wheelers, four wheelers, air planes and ships. Stability of an automobile – stability of a two wheel vehicle –Stabilization of ship.	4	
SECOND INTERNAL EXAM			
V	Introduction to vibrations – free vibrations of single degree freedom systems – energy Method	2	20%
	Undamped and damped free vibrations – viscous damping – critical damping - logarithmic decrement - Coulomb damping – harmonically excited vibrations	3	
	Response of an undamped and damped system – beat phenomenon - transmissibility	2	
VI	Whirling of shafts – critical speed - free torsional vibrations – self excitation and stability analysis - vibration control - vibration isolation – vibration absorbers	4	20%
	Introduction to multi-degree freedom systems - vibration measurement - accelerometer – seismometer – vibration exciters	3	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME306	ADVANCED MANUFACTURING TECHNOLOGY	3-0-0-3	2016

Pre requisite: ME 220 Manufacturing Technology, ME303 Machine Tools and Digital Manufacturing

Course Objectives

1. To introduce machining principles and processes in the manufacturing of precision components and products that use conventional and nonconventional technologies.
2. To give basic understanding of the machining capabilities, limitations, and productivity of advanced manufacturing processes.
3. To describe how PLC's operate and how they control automated equipment and systems
4. To demonstrate tool path simulations with CNC powered equipment
5. To introduce CNC programming

Syllabus:-

Powder Metallurgy- Programmable Logic Controllers- CNC- non-traditional and micro machining process - high velocity forming of metals-material additional process.

Expected outcome:

The students will be able to

i. Become conversant with the non- traditional machining process and to appreciate the effect of process parameters on the surface integrity aspects during the non- traditional machining process.
ii. Appreciate the use of an EDM as a non traditional method of machining complex and hard materials.
iii. Prescribe a laser materials processing technique suitable for a given product with material, size, precision, and surface quality requirements.
iv. Program and operate a CNC mill and lathe.
v. Select the tool material and machining process parameters.

Text books/References

1. ASTME, High velocity forming of metals, PHI, 1968.
2. Davies K and Austin E.R, Developments in high speed metal forming, the machinery publishing Co, 1970.
3. Ibrahim Zeid, R Sivasubrahmanian CAD/CAM: Theory & Practice, McGraw Hill Education, 2009
4. Jain V.K., Introduction to Micromachining, Narosa publishers,2014
5. M.P. Groover, E.M. Zimmers, Jr. CAD/CAM; Computer Aided Design and Manufacturing, Prentice Hall of India, 1987
6. Petruzella Frank.D., Programmable logic controllers,McGraw Hill,2016
7. Yoram Koren, Computer control of manufacturing systems, TMH,2006

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam. Marks**
I	Introduction: Need and comparison between traditional, non-traditional and micro & nano machining process.	1	**15%**
	Powder Metallurgy: Need of P/M - Powder Production methods:- Atomization, electrolysıs, Reduction of oxides, Carbonyls (Process parameters, characteristics of powder produced in each method).	1	
	Powder characteristics: properties of fine powder, size, size distribution, shape, compressibility, purity etc.	1	
	Mixing – Compaction:- techniques, pressure distribution, HIP & CIP.	1	
	Mechanism of sintering, driving force for pore shirking, solid and liquid phase sintering - Impregnation and Infiltration Advantages, disadvantages and specific applications of P/M.	1	
	Programmable Logic Controllers (PLC): need – relays - logic ladder program –timers, simple problems only.	1	
	Point to point, straight cut and contouring positioning - incremental and absolute systems – open loop and closed loop systems - control loops in contouring systems: principle of operation.	1	
II	DDA integrator:-Principle of operation, exponential deceleration –liner, circular and complete interpolator.	1	**15%**
	NC part programming: part programming fundamentals - manual programming –	1	
	NC coordinate systems and axes — sequence number, preparatory functions, dimension words, speed word, feed world, tool world, miscellaneous functions –	1	
	Computer aided part programming:– CNC languages – APT language structure: geometry commands, motion	1	
	commands, postprocessor commands, compilation control commands	1	
	Programming exercises: simple problems on turning and drilling etc - machining centers- 5 axis machining **(*At least one programming exercise must be included in the end semester University examination).***	2	
	FIRST INTERNAL EXAMINATION		

III	Electric Discharge Machining (EDM):- Mechanism of metal removal, dielectric fluid, spark generation, recast layer and attributes of process characteristics on MRR, accuracy, HAZ etc, Wire EDM, applications and accessories.	3	**15%**
	Ultrasonic Machining (USM):-mechanics of cutting, effects of parameters on amplitude, frequency of vibration, grain diameter, slurry, tool material attributes and hardness of work material, applications.	2	
	Electro chemical machining (ECM):- Mechanism of metal removal attributes of process characteristics on MRR, accuracy, surface roughness etc, application and limitations.	1	
IV	Laser Beam Machining (LBM), Electron Beam Machining (EBM), Plasma arc Machining (PAM), Ion beam Machining(IBM) - Mechanism of metal removal, attributes of process characteristics on MRR, accuracy etc and structure of HAZ compared with conventional process; application, comparative study of advantages and limitations of each process.	3	**15%**
	Abrasive Jet Machining (AJM), Abrasive Water Jet Machining **(AWJM)** - Working principle, Mechanism of metal removal, Influence of process parameters, Applications, Advantages & disadvantages.	3	
	SECOND INTERNAL EXAMINATION		
V	High velocity forming of metals:-effects of high speeds on the stress strain relationship steel, aluminum, Copper – comparison of conventional and high velocity forming methods- deformation velocity, material behavior, stain distribution.	3	**20%**
	Stress waves and deformation in solids – types of elastic body waves- relation at free boundaries- relative particle velocity.	2	
	Sheet metal forming: - explosive forming:-process variable, properties of explosively formed parts, etc.	2	
	Electro hydraulic forming: - theory, process variables, etc, comparison with explosive forming.	1	
V1	Micromachining: Diamond turn mechanism, material removal mechanism, applications.	1	**20%**
	Advanced finishing processes: - Abrasive Flow Machining, Magnetic Abrasive Finishing.	2	
	Magnetorheological Abrasive Flow Finishing, Magnetic Float Polishing, Elastic Emission Machining.	3	
	Material addition process:- stereo-lithography, selective laser sintering, 3D Printing, fused deposition modeling, laminated object manufacturing, , laser engineered net-shaping, laser welding, LIGA process.	2	

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME308	COMPUTER AIDED DESIGN AND ANALYSIS	3-0-0-3	2016

Prerequisite: ME201 Mechanics of solids

Course Objectives:

1. To impart basic knowledge on Computer Aided Design methods and procedures
2. To introduce the fundamentals of solid modelling
3. To introduce the concepts of finite element analysis procedures.

Syllabus

Introduction to CAD/CAM, Basics of geometric and solid modeling, transformation, representation points, lines, surfaces and solid models. Introduction to finite element analysis, solution procedures, interpolation, isoparametric formulation, applications.

Expected outcome:

The students will be able to

1. Gain a basic knowledge on Computer Aided Design methods and procedures
2. Understand the fundamentals of solid modelling
3. Have a basic knowledge in finite element analysis procedures.

Text Books:

1. M.P. Groover, E.M. Zimmers, Jr.CAD/CAM; Computer Aided Design and Manufacturing, Prentice Hall of India, 1987
2. T. R. Chandrupatla and A. D. Belagundu, Introduction to Finite Elements in Engineering, Pearson Education, 2001

References:

1. Chris Mcmahon and Jimmie Browne - CAD/CAM – Principle Practice and Manufacturing Management, Addision Wesley England,1998
2. D. F. Rogers and J. A. Adams, Mathematical Elements in Computer Graphics, McGraw-Hill,1990
3. Daryl Logan, A First course in Finite Element Method, Thomson Learning,2007
4. David V Hutton, Fundamentals of Finite Element Analysis, THM,2003
5. Donald Hearn, M. Pauline Baker and Warren Carithers, Computer Graphics with open GL, Pearson Education,2001
6. Grigore Burdea, Philippe Coiffet, Virtual Reality Technology, John Wiley and sons,2003
7. Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill,2007
8. P. Radhakrishnan and S. Subramanyan, CAD / CAM / CIM, New Age Int. Ltd.,2008

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Introduction to CAD , Historical developments, Industrial look at CAD, Comparison of CAD with traditional designing, Application of computers in Design	2	15%
	Basics of geometric and solid modeling, Packages for CAD/CAM/CAE/CAPP	1	
	Hardware in CAD components, user interaction devices, design database, graphic Standards, data Exchange Formats, virtual Reality.	4	
II	Transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling.	4	15%
	Shearing,rotation, reflection and translation, combined transformations, orthographic and perspective projections, reconstruction of 3-D objects.	3	
FIRST INTERNAL EXAM			
III	Algebraic and geometric forms, tangents and normal, blending functions, reparametrization, straight lines, conics, cubic splines, Bezier curves and B-spline curves.	4	15%
	Plane surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, bezier surface, B-spline surfaces and their modeling techniques.	3	
IV	Solid models and representation scheme, boundary representation, constructive solid geometry.	3	15%
	Sweep representation, cell decomposition, spatial occupancy enumeration, coordinate systems for solid modeling.	4	
SECOND INTERNAL EXAM			
V	Introduction to finite element analysis - steps involved in FEM- Preprocessing phase – discretisation - types of elements	2	20%
	Formulation of stiffness matrix (direct method, 1-D element) - formulation of load vector - assembly of global equations - implementation of boundary conditions - solution procedure - post processing phase	3	
	Simple problems with axial bar element (structural problems only)	2	
VI	Interpolation – selection of interpolation functions - CST element - isoparametric formulation (using minimum PE theorem) – Gauss-quadrature	4	20%

	Solution of 2D plane stress solid mechanics problems (linear static analysis)	3	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME312	METROLOGY AND INSTRUMENTATION	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To understand the working of linear and angular measuring instruments.
- To familiarize with the working of optical measuring instruments and fundamentals of limits and limit gauges.
- To give basic idea about various methods for measurement of screw thread and surface finish parameters.
- To give an exposure to advanced measuring devices and machine tool metrology.
- To provide students an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement.
- To provide basic idea about working principle and applications of devices for measurement of force and torque; strain and stress and temperature.

Syllabus

Introduction to Metrology - Errors in Measurement- Basic standards of length - Linear Measurement, Comparators - Angular Measurement - Limits and Limit gauges - Optical Measuring Instruments - Screw thread measurement - Measurement of surface texture - Machine tool metrology - Coordinate Measuring Machine (CMM) and Machine Vision.
Introduction to Mechanical Measurement - Motion and Dimension measurement, Strain and Stress Measurement - Measurement of Force, Torque and Temperature Measurement.

Expected outcome:

The students will be able to

i. Understand the working of linear and angular measuring instruments.
ii. Know the fundamentals of limits and limit gauges, various methods for measurement of screw thread and surface roughness parameters and the working of optical measuring instruments.
iii. Get an exposure to advanced measuring devices and machine tool metrology.
iv. Acquire an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement.
v. Get basic idea about working principle and applications of devices for measurement of force and torque; strain and stress and temperature.

Text books

1. Anand K Bewoor, Vinay A Kulkarni, Metrology & Measurement, McGraw-Hill, 2009
2. Ernest O. Doebelin, Dhanesh N. Manik, Measurement Systems Application and Design, McGraw-Hill, 2004
3. Galyer J.F.W., Schotbolt C.R., Metrology for Engineers, ELBS,1990
4. Thomas G. Beckwith, John H. L., Roy D. M., Mechanical Measurements, 6/E , Pearson Prentice Hall, 2007

Reference books

1. ASME, Hand book of Industrial Metrology,1998
2. Hume K. J., Engineering Metrology, Macdonald &Co. Ltd.,1990
3. J.P.Holman, Experimental Methods for Engineers,Mcgraw-Hill, 2007
4. Sharp K.W.B., Practical Engineering Metrology, Sir Isaac Pitman & Sons Ltd.,1958

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Concept of measurement:-Introduction to Metrology; Need for high precision measurements; Terminologies in Measurement-Precision, accuracy, sensitivity, calibration.	1	15%
	Errors in Measurement, types of errors, Abbe's Principle.	1	
	Basic standards of length- Line standard, End standards, Wavelength standard; Various Shop floor standards.	1	
	Linear Measurement – Slip gauges, wringing, grades; Surface plate; Dial indicators; Height gauges and Vernier calipers.	1	
	Comparators- mechanical, electrical, optical and pneumatic.	1	
	Angular Measurement – Bevel protractor; Sine Bar, principle and use of sine bar, sine centre; Angle gauges.	1	
	Sprit level; Angle Dekkor; Clinometers.	1	
II	Limits and Limit gauges – Making to suit, selective assembly, systems of limits and fits; Types of fits; Hole basis system and Shaft basis system.	1	15%
	Standard systems of limits and fits; Shaft and Hole system; Tolerance, allowance and deviation (as per BIS).	1	
	Simple problems on tolerance and allowance, shaft and hole system.	1	
	Limit Gauges – GO and NO GO gauges; types of limit gauges.	1	
	Gauge design - Taylor's principle of gauging; Gauge tolerance, disposition of gauge tolerance, wear allowance.	1	
	Optical Measuring Instruments: - Benefits of using light waves as standards; Monochromatic light; Principle of Interference.	1	
	Interference band using optical flat, application in surface measurement.	1	
	Interferometers – NPL flatness interferometer, Pitter-NPL gauge interferometer.	1	
	FIRST INTERNAL EXAMINATION		
	Screw thread measurement – Screw thread terminology; Measurement of major diameter; Measurement of minor or root diameter.	1	
	Measurement of pitch; Measurement of effective diameter with two wire method and three wire method.	1	
	Measurement of flank angle and form by profile projector and	1	

III	microscope.		**15%**
	Measurement of surface texture – Meaning of surface texture, roughness and waviness; Analysis of surface traces, peak to valley height, R.M.S. value, Centre Line Average and R_a value, Rt, Rz etc.	**1**	
	Methods of measuring surface roughness – Stylus probe, Tomlinson surface meter, Talysurf; Terms used in surface roughness measurement – assessment length, roughness width cut-off, sampling length and evaluation length.	**1**	
	Interference method for measuring surface roughness – using optical flat and interferometers.	**1**	
	Autocollimator, principle and use of autocollimator.	**1**	
IV	Machine tool metrology – Alignment testing of machine tools like lathe, milling machine, drilling machine.	**1**	**15%**
	Advanced measuring devices – Laser interferometers.	**1**	
	Coordinate Measuring Machine (CMM) – Introduction to CMM; Components and construction of CMM.	**1**	
	Types of CMM; Advantages and application of CMM	**1**	
	CMM probes, types of probes – contact probes and non contact probes	**1**	
	Machine Vision – Introduction to machine vision, functions, applications and advantages of machine vision.	**1**	
	Steps in machine vision	**1**	
	SECOND INTERNAL EXAMINATION		
V	Introduction to Mechanical Measurement – significance of mechanical measurement; Fundamental methods of measurement; Classification of measuring instrument.	**1**	**20%**
	Stages in generalized measuring system – Sensor-Transducer stage, Signal-Conditioning stage, Readout-Recording stage; Types of input quantities; Active and Passive transducers.	**1**	
	Performance characteristic of measuring devices – Static characteristics – Accuracy, Precision, Repeatability, Sensitivity, Reproducibility, Drift, Resolution, Threshold, Hysteresis, Static calibration.	**1**	
	Dynamic characteristics- different order systems and their response-, Measuring lag, Fidelity, Dynamic error; Types of errors in measurement.	**1**	
	Transducers – Working, Classification of transducers.	**1**	
	Motion and Dimension measurement – LVDT – Principle, applications, advantages and limitations.	**1**	
V1	Strain and Stress Measurement - Electrical resistance strain gauge - Principle, operation.	**1**	
	Measurement of Force and Torque – Strain-Gauge Load Cells, Hydraulic and Pneumatic load cells – basic principle and three component force measurement using piezoelectric quartz crystal.	**1**	
	Torque Measurement – Dynamometers – Mechanical, Hydraulic and Electrical.	**1**	
	Vibration measurement – Vibrometers and Accelerometers – Basic principles and operation.	**1**	

	Temperature Measurement – Use of Thermal Expansion – Liquid-in-glass thermometers, Bimetallic strip thermometer, Pressure thermometers.	**1**	**20%**
	Thermocouples – Principle, application laws for Thermocouples, Thermocouple materials and construction, measurement of Thermocouple EMF.	**1**	
	Resistance Temperature Detectors (RTD); Thermistors; Pyrometers (Basic Principles).	**1**	
END SEMESTER EXAMINATION			

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Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

KTU Est 2014

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME332	COMPUTER AIDED DESIGN AND ANALYSIS LAB	0-0-3-1	2016

Prerequisite: ME308 Computer aided design and analysis

Course Objectives:

- To provide working knowledge on Computer Aided Design methods and procedures
- To impart training on solid modelling software
- To impart training on finite element analysis software

Syllabus

Introduction to solid modeling and Finite Element Analysis software.

Exercises on modeling and assembly.

a. Creation of higher end 3D solid models.(minimum 3 models)

b. Creation of assembled views of riveted joints, cotter joints and shaft couplings. (minimum 3 models)

Exercises on the application of Finite Element Method/Finite Volume Method to engineering systems:-

a. Structural analysis. (minimum 3 problems)

b. Thermal analysis. (minimum 2 problems)

c. Fluid flow analysis. (minimum 1 problem)

Expected outcome:

The students will be able to

i. Gain working knowledge in Computer Aided Design methods and procedures

ii. Solve simple structural, heat and fluid flow problems using standard software

Points to note:

- Any appropriate solid modeling software (like CATIA, Solids Works, ProE, IDEAS, Siemens Solid Edge and NX, free software, etc.) and package (like ANSYS, Comsol Multi Physics, NASTRAN, ABAQUS, ADINA, Siemens Femap Nastran,free software etc.) may be used.
- **Evaluation**

  Class exercises 60 marks
  Regular class viva 10 marks
  Final internal exam using software 30 marks
  All the above three evaluations are mandatory.

References Books:

1. Daryl Logan, A First course in Finite Element Method, Thomson Learning, 2007
2. David V Hutton, Fundamentals of Finite Element Analysis, Tata McGraw Hill,2003
3. Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill, 2007
4. Mikell P. Groover and Emory W. Zimmer, CAD/ CAM – Computer aided design and manufacturing, Pearson Education,1987
5. T. R. Chandrupatla and A. D. Belagundu, Introduction to Finite Elements in Engineering, Pearson Education, 2012

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME334	MANUFACTURING TECHNOLOGY LABORATORY – II	0-0-3-1	2016

Prerequisite: ME312 Metrology and Instrumentation

Course Objectives:

- To provide programming practice on CNC machine tools
- To impart knowledge on the fundamental concepts and principles of metrology
- To explain the need of various modern measuring instruments and precision measurements

List of Experiments/Exercises:	Sessions
Exercise on grinding machine	1
Study and preparation of program, simulation and exercise on CNC lathe:-turning, step turning, taper turning, thread cutting, ball and cup turning etc.	2
Study and preparation of program, simulation and exercise on CNC milling machine: - surface milling, pocket milling, contour milling etc.	2
Basics for mechanical measurements Calibration of vernier caliper, micrometer and dial gauge etc. Determination of dimensions of given specimen using vernier caliper, micrometer, height gauge, bore dial gauge etc. Determination of dimensions of a rectangular, square, cylindrical specimens using slip gauges and comparing with height gauge/vernier caliper etc	1
Experiments on Limits, Fits and Tolerance Determine the class of fits between given shaft and hole. etc.	
Linear measurements Study of different linear measuring instruments. Calibration of LVDT using slip gauges.	1
Straightness error measurement Study of different straightness error measuring instruments – basic principle of auto collimator and spirit level. Measurement of straightness error of a CI surface plate using auto collimator and comparing with sprit level. laser interferometer used to determine straightness error To check straightness error of a straight edge by the wedge method using slip gauges.	1
Angle measurements Angular measurements using bevel protractor, combination sets, clinometers, angle dekkor etc. Measurement of angle and width of a V-block and comparing with combination sets. Measurement of angle using sine bar of different samples.	1

Out of roundness measurement Study of different methods used for measurement out of roundness Measurement of out of roundness using form measuring instrument Measurement of out of roundness using V-block and dial gauge Measurement of out of roundness using bench centre and dial gauge etc.	**1**
Screw thread measurement Measurement of screw thread parameters using two wire and three wire method. Measurement of screw thread parameters using tool maker's microscope etc. Measurement of screw thread parameters using thread ring gage, thread plug gage, thread snap gage, screw thread micrometer, optical comparator etc.	**1**
Bore measurement Measurement of a bore by two ball method. Measurement of a bore by four ball method. Bore measurement using slip gauges and rollers. Bore measurement using bore dial gauge etc.	**1**
Calibration and determination of uncertainties Strain measurement using strain gauge load cells. Calibration of a cantilever strain gauge load cell. **Rotation measurement** Determination of rpm using tachometer, optical tachometer and stroboscope, etc.	**1**
Area determination Study of planimeter and Green's theorem Determination of given irregular area using planimeter.	**1**
Gear metrology Types of gears – gear terminology – gear errors - study of Profile Projector. Measurement of profile error and gear parameters using profile projector etc. **Use of Comparators** Exercise on comparators: mechanical, optical, pneumatic and electronic comparators.	**1**
Use of Tool makers microscope Study of tool maker's microscope – use at shop floor applications. Measurement of gear tooth parameters using tool maker's microscope. Measurement of different angles of single point cutting tool using tool maker's microscope.	**1**
Surface roughness measurement Measurement of surface roughness using surface profilometer /roughness measuring machine of turned, milled, grounded, lapped and glass etc specimens.	**1**
Squareness measurement Determination of squareness of a trisquare using angle plate and slip gauges.	**1**
Flatness measurement Study of optical flat and variation of fringe patterns for different surfaces. Determination of parallelism error between micrometer faces. Compare given surface using optical flat with interpretation chart**.**	**1**
Vibration measurement Measurement of displacement, velocity and acceleration of vibration.	**1**

Use of Pneumatic comparator Checking the limits of dimensional tolerances using pneumatic comparator Calibration using air plug gauge etc	**1**

Reference books

1. Collett, C.V. and Hope, A.D, Engineering Measurements, Second edition, ELBS/Longman,1983
2. Sharp K.W.B. and Hume, Practical Engineering Metrology, Sir Isaac Pitman and sons Ltd, London,1958
3. Shotbolt C.R. and Gayler J.F.W, Metrology for Engineers, 5th edition, ELBS, London,1990
4. Yoram Koren, Numerical Control of Machine Tools, McGraw-Hill,1983

A minimum of 12 experiments are mandatory but the experiments/exercises in CNC machines are mandatory.

The academic evaluation shall be carried out by faculty.

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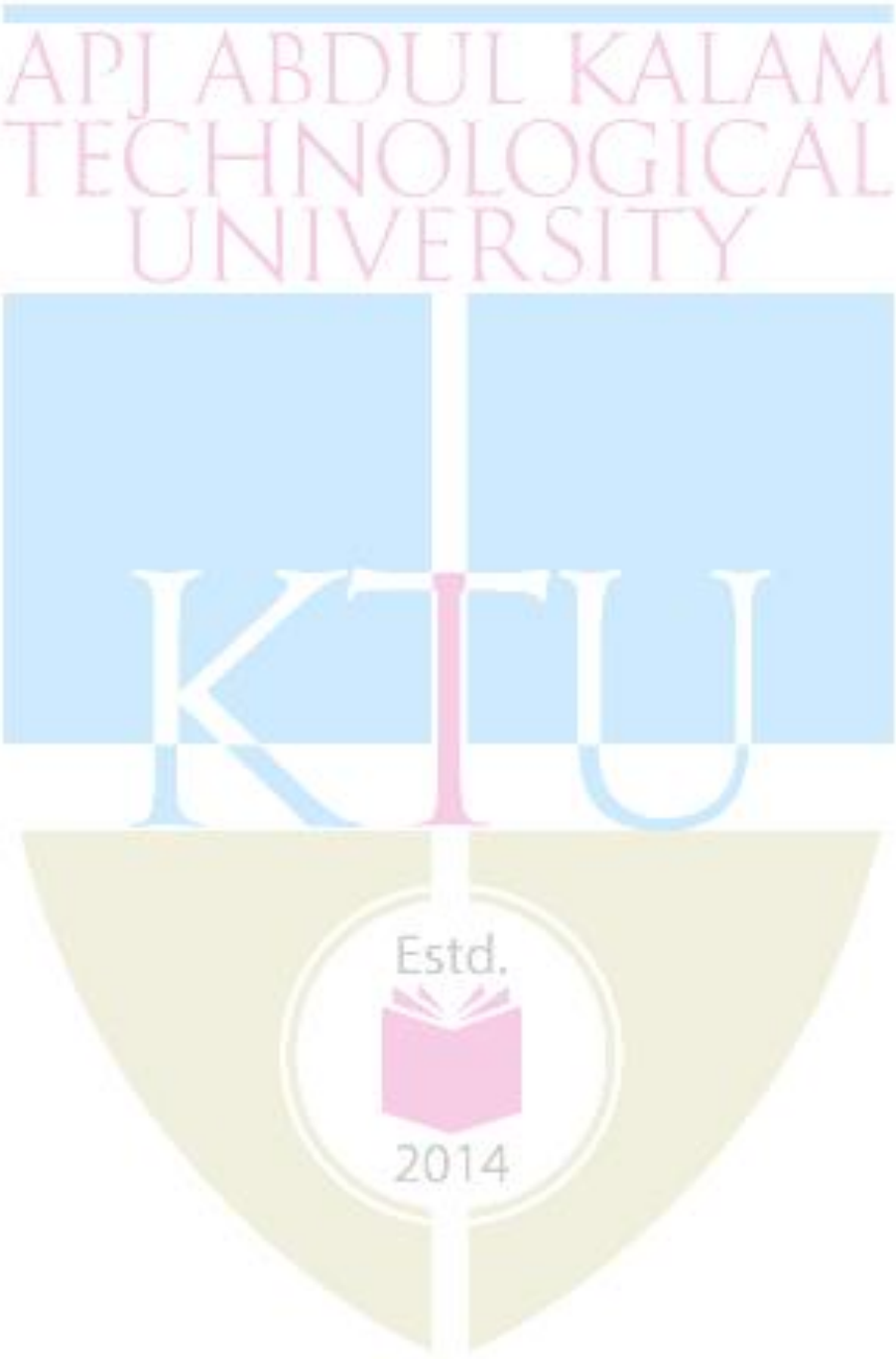
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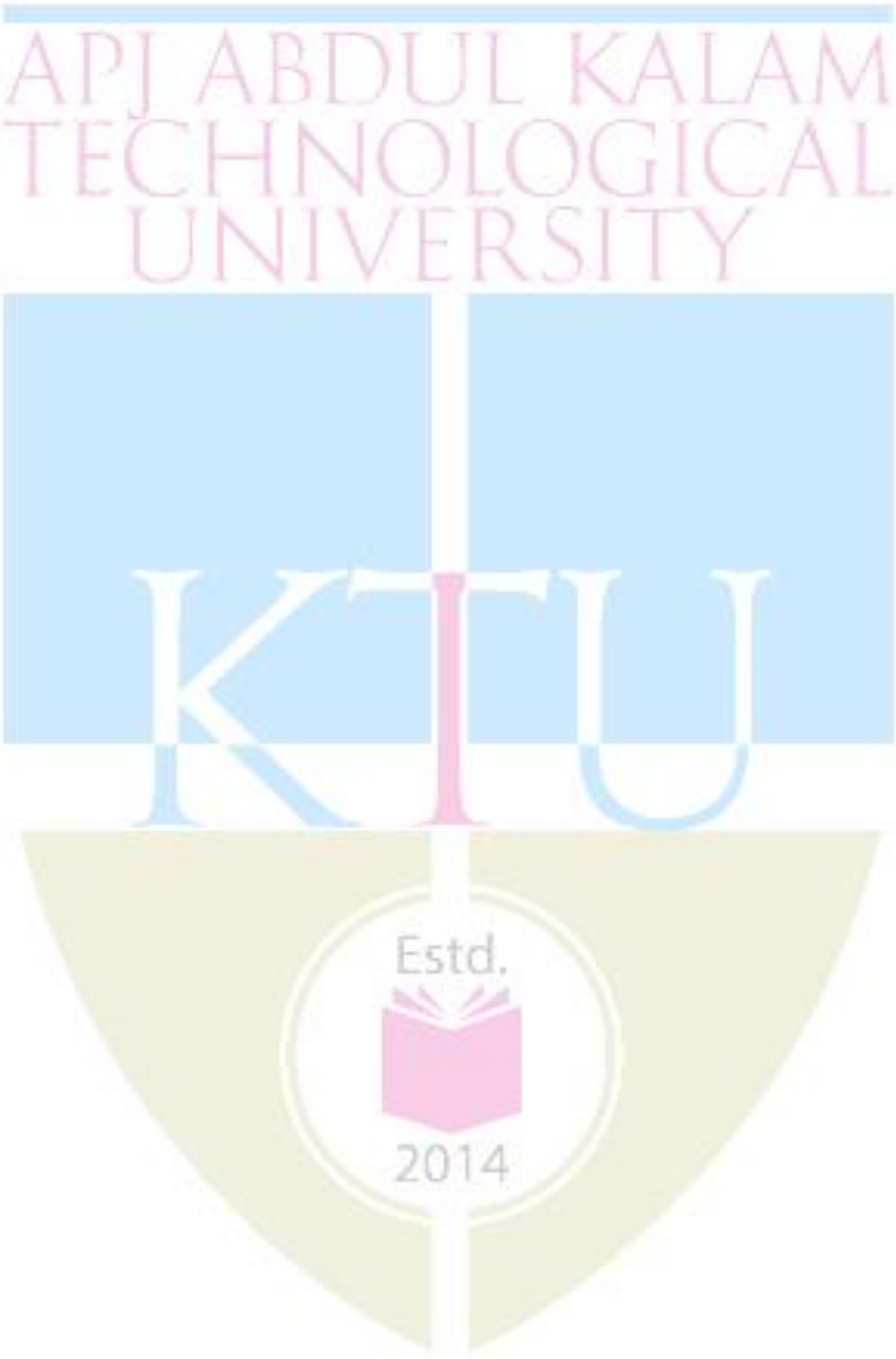
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Course code	Course Name	L-T-P - Credits	Year of Introduction
**352	Comprehensive Examination	0-1-1-2	2016
Prerequisite : Nil			

Course Objectives

- To assess the comprehensive knowledge gained in basic courses relevant to the branch of study
- To comprehend the questions asked and answer them with confidence.

Assessment

Oral examination – To be conducted weekly during the slot allotted for the course in the curriculum (@ three students/hour) – 50 marks
Written examination - To be conducted by the Dept. immediately after the second internal examination– common to all students of the same branch – objective type (1 hour duration)– 50 multiple choice questions (4 choices) of 1 mark each covering all the courses up to and including semester V – no negative marks – 50 marks.

Note: Both oral and written examinations are mandatory. But separate minimum marks is not insisted for pass. If a students does not complete any of the two assessments, grade I shall be awarded and the final grade shall be given only after the completion of both the assessments.
The two hours allotted for the course may be used by the students for library reading and for oral assessment.

Expected outcome .

- The students will be confident in discussing the fundamental aspects of any engineering problem/situation and give answers in dealing with them

KTU STUDENTS

SYLLABUS

Elective 2

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME362	Control System Engineering	3-0-0-3	2016

Course Objectives: :

1. To introduce the concepts of controls and modelling of physical systems.
2. To give idea on system response analysis and stability of systems.
3. To use different methods to analyse stability of control systems

Syllabus:

Control systems and components, Mathematical models, Block diagrams, Signal Flow graphs, Transient and Steady state response analysis, Stability , Routh's stability criterion, Root locus method. Frequency response analysis using polar plots ,Bode plots, Nyquist stability criterion

Expected Outcomes: At the end of the course students will be able

1. To model and analyse physical systems.
2. To analyse the stability of feedback control systems

Text books:

1. Kuo, B. C., Automatic Control Systems, Prentice Hall,2012
2. Thaler and Brown, Analysis and Design of Feedback Control Systems, McGraw Hill, 1960.
3. Nagrath I J and Gopal M, Control Systems Engineering, New Age India Pvt Limited, 2009

References:

1. Ogata, K., Modern Control Engineering, Pearson Education, 2004
2. NPTEL courses, http//nptel.iitm.ac.in/courses.php, web and video courses on Control Engineering

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to control systems. Elementary ideas on types of control systems- Open loop and closed loop systems, Servo systems, Automatic regulating systems, Process control systems, Adaptive control systems, Learning control systems, Discrete control systems, Multivariable control systems, Linear and Non-linear systems. Elementary ideas on types of controls- proportional, integral, proportional integral, proportional integral derivative controls. Direct and indirect controls. Mathematical models of physical systems – typical examples of mechanical, thermal, electrical, hydraulic and pneumatic systems.	7	15%
II	Block diagram, transfer function, reduction of block diagrams, signal flow graphs :Manson's gain formula. Control system components – servomotors, stepper motor, synchros, hydraulic pumps and motors, hydraulic valves, pneumatic bellows, pneumatic valve, pneumatic relay, pneumatic actuator, gyroscopes (elementary ideas only. No derivations)	7	15%

	FIRST INTERNAL EXAMINATION		
III	System response- Time response of first and second order systems, steady state errors and error constants, specifications in time domain. Effect of pole locations, Concept of stability, Routh's stability criterion	**7**	**15%**
IV	Root locus method of analysis and design. Lead and lag compensation	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Frequency response analysis- relationship between time & frequency response, Bode's plot, stability in frequency domain, gain margin and Phase margin	**7**	**20%**
V1	Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME364	Turbomachinery	3-0-0-3	2016

Prerequisite : ME205 Thermodynamics

Course Objectives: :

1. To know the principle of operation of turbomachines
2. To provide students thorough understanding of velocity triangles, turbomachinery
3. To introduce students to fans, turbines, pumps etc..

Syllabus:

Definition of turbomachine, Application of first and second laws of thermodynamics to turbomachines, Efficiencies, Centrifugal fans and blowers, Centrifugal Compressors, Axial flow compressors, Axial and radial flow turbines

Expected Outcomes:

The students will be able to

1. Understand the operation of turbomachines
2. Gain ideas on performance characteristics, governing and selection of turbomachinery.

Text books

1. Bruneck, Fans, Pergamom Press, 1973.
2. Dixon, S.I, Fluid Mechanics and Thermodynamics of Turbomachinery , Pergamom, Press, 1990.
3. Ganesan .V, Gas Turbines , Tata McGraw Hill Pub. Co., New Delhi, 1999.
4. Stepanff, A.J, Blowers and Pumps , John Wiley and Sons Inc., 1965.
5. Yahya, S.H, Turbines, Compressor and Fans , Tata Mc Graw Hill, 1996.

Reference books

1. Earl Logan, Jr, Hand book of Turbomachinery, Marcel Dekker Inc, 1992.
2. Shepherd, D.G, Principles of Turbomachinery , Macmillan, 1969.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Definition of turbomachine, parts of turbomachines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Effect of Reynolds number, Unit and specific quantities, model studies.	7	15%
II	Application of first and second laws of thermodynamics to turbomachines, Efficiencies of turbomachines. Stage velocity triangles, work and efficiency for compressors and turbines	7	15%
FIRST INTERNAL EXAMINATION			

III	Centrifugal fans and blowers : Types, stage and design parameters, flow analysis in impeller blades, volute and diffusers, losses, characteristics curves and selection, fan drives and fan noise.	**7**	**15%**
IV	Centrifugal Compressors: Construction details, types, impeller flow losses, slip factor, diffuser analysis, losses and performance curves.	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Axial flow compressors : Stage velocity triangles, enthalpy-entropy diagrams, stage losses and efficiency, work done factor, simple stage design problems and performance characteristics.	**7**	**20%**
V1	Axial and radial flow turbines : Stage velocity diagrams, reaction stages, losses and coefficients blade design principles, testing and performance characteristics.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME366	ADVANCED METAL JOINING TECHNOLOGY	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To expose the students to the fundamental concepts of advanced welding technologies and their relevance

Syllabus

Radiant energy welding, Electron beam and Laser beam welding, Plasma arc welding, Micro plasma welding, Magnetically impelled arc butt welding, Underwater welding, Explosive welding, Adhesive bonding, Friction welding, Friction stir welding, Friction stir processing, Diffusion welding, Cold Pressure welding, Ultrasonic welding, Vacuum brazing.

Expected outcome

- The students will be able to understand the advancements in welding technologies and processes, their significance, application areas etc. leading to the development of products and processes.

References Books:

1. ASM Metals Hand Book "Welding and Brazing", Vol. 6, ASM, Ohio, 1988.
2. Parmar R.S., "Welding Processes and Technology", Khanna Publishers, Delhi, 1998.
3. Parmer R. S., Welding Engineering and Technology", Khanna Publishers, 1997
4. Rossi, Welding Engineering, McGraw Hill, 1954.
5. Schwartz M.M., "Metals Joining Manual", McGraw-Hill Inc., 1979.
6. Udin et al., Welding for Engineers, John Wiley & Sons, New York, 1967.
7. Welding Engineers Hand Book- ASHE Vol . I, II, III and IV.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Radiant energy welding: Electron Beam Welding-Background of the Process, Guns, Weld Environment, Welding in Different Degrees of Vacuum, Equipment and Safety, Joint Design, Applications, Laser Beam Welding, Physics of Lasers, Types of Lasers, Process Parameters, Applications and Limitations.	7	15%

II	Diffusion Welding- theory and Principle of Process, Key Variables, Intermediate Materials, Deformation Welding, Equipment and Tooling, Joint Design, Economics, Advantages and Limitations, Materials and Applications, Cold Pressure Welding- Process, Equipment and Setup, Applications	6	15%
FIRST INTERNAL EXAM			
III	Explosive Welding- theory and Key Variables, Parameters, Weld Quality, Equipment and Tooling, Advantages and Limitations, Joint Design, Materials and Applications, Adhesive Bonding- theory and Key Parameters, Physical Characteristics, Metal Adhesive, Equipment, Design, Economics of Process, Materials and Applications.	7	15%
IV	Ultrasonic welding-Principles of operation, Process Characteristics and Applications, Vacuum brazing-Theory, Mechanisms and Key Variables, Equipment and Tooling, Stop-Off and Parting Agents, Advantages, Limitations, Economics Materials and Applications.	6	15%
SECOND INTERNAL EXAM			
V	Plasma arc welding: Plasma Arc Welding- theory and Principles, Transferred arc and Non-Transferred arc Techniques, Equipment and Tooling, Joint Design Advantages, Disadvantages, Economics, Materials and Applications, Needle Arc Micro Plasma Welding - Characteristics of Process, Operating Characteristics, Fixturing and Joint Design, Shielding, Weld Penetration and Shape, Applications, Magnetically impelled arc butt (MIAB) welding, Under Water Welding- Wet and Dry Under Water Welding	8	20%
VI	Friction Welding- Basic Principles, Process Variants, Different Stages of Friction Welding, Mechanism of Bonding, Influence of Process Parameters, Weld Quality and Process Control, Joining of Dissimilar Materials, Advantages, Limitations and Applications, Friction Stir Welding-Metal flow phenomena, tools, process variables and applications, Friction Stir Processing- Process, Application	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

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2014

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME368	Marketing Management	3-0-0-3	2016

Prerequisite : Nil

Course Objectives: :

- To introduce the concept of market and marketing
- To give idea about launching a new product
- To introduce the various marketing strategies

Syllabus:

Introduction to marketing, Social and Marketing planning, Consumer behavior, Marketing communication, Designing the message, New trends in marketing

Expected Outcomes:

The students will be able to

i. state the role and functions of marketing within a range of organizations.
ii. describe key marketing concepts, theories and techniques for analyzing a variety of marketing situations.
iii. identify and demonstrate the dynamic nature of the environment in which marketing decisions are taken
iv. synthesize ideas into a marketing plan

Text books:

1. Majumdar R., Marketing Research, Text, Applications and Case Studies, New Age International (P), 1991
2. Ramaswamy V.S. & Namkumari S, Marketing Management: Planning, Implementation and Control, Macmillan India Limited, 2002
3. Robert, Marketing Research, Prentice Hall of India,1999
4. T N Chabra and S K Grover : Marketing management, Dhanpat Rai, 2007

Reference books:

1. Kotler P, Marketing Management: Analysis, Planning, Implementation and Control, Prentice Hall of India,1993
2. Stanton W.J., Etzel M.J. & Walker B.J, Fundamentals of Marketing, McGraw Hill International Edition, 1994

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to marketing - concept of market and marketing – marketing environment - controllable factors - factors directed by top management - factors directed by marketing - uncontrollable factors - demography, economic conditions, competition.	7	15%
II	Social and Marketing planning - marketing planning process - Boston consultancy group model - marketing mix - marketing mix variables. Developing, testing and launching of new products .	7	15%

	FIRST INTERNAL EXAMINATION		
III	Market segmentation and market targeting - introduction to segmentation - targeting and product positioning. Marketing research - need and scope - marketing research process – research objectives, developing research plan, collecting information, analysis, and findings.	**7**	**15%**
IV	Consumer behaviour - factors influencing consumer behaviour - perceived risks Product life cycle - marketing strategies for different stages of product life cycle	**6**	**15%**
SECOND INTERNAL EXAMINATION			
V	Marketing communication - marketing mix variables - steps in developing effective communication - identification of target audience - determination of communication objectives	**7**	**20%**
V1	Designing the message - selecting the communication channels - promotion mix evaluation - advertising and sales promotion - factors in advertising - sales promotion tools. New trends in marketing- Brand management - significance of branding to consumers and firms	**8**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME372	Operations Research	3-0-0-3	2016

Prerequisite -Nil

Course Objectives:

- To understand the role of operation research in decision making
- To impart the various operation research techniques for effective problem solving.

Syllabus:

Operations research models, linear programming, transportation problem, assignment problem, sequencing problem, network analysis, queuing theory, inventory control, decision theory, game theory – simulation.

Expected Outcome:

- The students will be able to understand operations research techniques and apply them in solving practical problems in industry.

Text Books:

1. Miller, D. M. and Schmidt, J. W., Industrial Engineering and Operations Research, John Wiley & Sons, Signapore, 1990.
2. Paneerselvam, R., Operations Research, Prentice Hall of India, New Delhi, 2008.
3. Pannerselvam, R., Design and Analysis of Algorithms, Prentice Hall of India, New Delhi, 2007.
4. Srinivasan, G. "Operations Research-Principles and Applications", Latest edition, PHI Pvt. Ltd., 2010.
5. Taha, H. A., Operations Research, Pearson, 2004.

Reference Books:

1. Banks, J., Carson, J. S., Nelson, B. L., and Nicol, D. M., Discrete-Event System Simulation, Third Edition, Pearson Education, Inc., 2001.
2. Goel, B. S. and Mittal, S. K., Operations Research, Pragati Prakashan, Meerut, 1999.
3. Ravindran, Phillips and Solberg, Operations Research Principles and Practice, Willey & Sons, 1987.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Basics of operations research–OR models–applications.	1	15%
	Linear programming – problem formulation	1	
	Graphical method	1	
	Simplex method	1	

	Big-M method	**1**	
	Two–phase method	**1**	
	Duality in linear programming	**1**	
II	Transportation problem – formulation – balanced & unbalanced transportation problems	**1**	**15%**
	North west corner rule – least cost method	**1**	
	Vogel's method –stepping stone method	**1**	
	MODI method	**1**	
	Assignment problem – formulation – optimal solution, Hungarian algorithm	**1**	
	Variants of assignment problems	**1**	
	Traveling salesman problem.	**1**	
FIRST INTERNAL EXAMINATION			
III	Sequencing problem– terminology and notations – assumptions – problems with *n* jobs through two machines	**1**	**15%**
	Problems with *n* jobs through three machines	**1**	
	Problems with *n* jobs through *m* machines.	**1**	
	Network analysis – basic terms – network construction – time analysis	**1**	
	Critical path method (CPM)	**1**	
	Programme evaluation and review technique (PERT)	**1**	
	Cost considerations in network analysis – crashing	**1**	
IV	Introduction to queuing theory–terminologies– classification of queuing models	**1**	**15%**
	Single server problems	**1**	
	Multi server problems	**1**	
	Inventory control – variables – deterministic inventory models – purchasing model without shortages	**1**	
	Manufacturing model without shortages	**1**	
	Purchasing model with shortages	**1**	
	Manufacturing model with shortages	**1**	
SECOND INTERNAL EXAMINATION			
V	Decision theory – steps in decision theory approach – decision making conditions	**1**	**20%**
	Decisions under conditions of risk	**1**	
	Decisions under uncertainty conditions	**1**	
	Decision tree analysis	**1**	
	Game theory – games with saddle points	**1**	
	Games without saddle points – 2 x 2 games	**1**	

	Graphical method for m x 2 & 2 x n games	**1**	
VI	Simulation – types of simulation – phases of simulation – applications– advantages and disadvantages	**1**	**20%**
	Design of simulation, models & experiments, model validation	**1**	
	Generation of random numbers	**1**	
	Monte Carlo simulation	**1**	
	Queuing simulation model	**1**	
	Inventory simulation model	**1**	
	Simulation languages	**1**	

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code.	Course Name	L-T-P-Credits	Year of Introduction
ME374	THEORY OF VIBRATIONS	3-0-0-3	2016

Prerequisite: ME304 Dynamics of machinery

Course Objectives

- To understand the principles of vibration theory.
- To introduce techniques for solving vibration problems.
- To enable development of mathematical model for engineering problems in vibrations.

Syllabus

Introduction to mechanical vibrations; Analysis of free, forced single degree of freedom systems; Damping; Vibration measuring instruments; Multi degree of freedom systems; Eigen value problems; Lagrange's equation; Vibration of continuous systems; Transient vibrations; Introduction to non linear and random vibrations.

Expected outcome

The students will be able to

i. formulate differential equations of motion of mechanical systems
ii. determine the natural frequencies of multi degree of freedom systems
iii. understand non linear and random vibrations.

Text Books:

1. Graham Kelly S, Schaum's outline of Mechanical Vibrations, Schaum's Outlines,1996
2. Singiresu S Rao, Mechanical Vibrations, Pearson, 2016
3. Thomson, W T , Theory of Vibration with Applications., Prentice Hall India,1981

References Books:

1. Den Hartog, J P, Mechanical Vibrations, McGrawHill, 1956.
2. Leonard Meirovitch, Elements of Vibration Analysis,McGraw Hill,1975.

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Introduction to mechanical vibrations- Simple harmonic motion- Natural frequency -Equation of motion-- Energy method-Rayleigh method	2	20%
	Free vibration of single degree of freedom (DOF) systems with damping- Viscous damping- Logarithmic decrement. Coulomb damping-Energy dissipated by damping- Structural damping -Equivalent viscous damping.	4	
II	Forced harmonic vibration- Magnification factor-Transmissibility-Vibration isolation-Base excitation-Rotating unbalance- whirling of shafts- Resonance Vibration measuring instruments. Seismometer-Accelerometer	5	15%
FIRST INTERNAL EXAM			
III	Two degree of freedom systems-Normal mode vibration-Principal co-ordinates-Coordinate coupling.	3	15%
	Beat phenomenon-Undamped vibration absorbers- Vibration dampers.	2	
IV	Multi degree of freedom systems- Matrix formulation- Influence coefficients-Flexibility matrix-Stiffness matrix	5	20%
	Eigen Value problem:Eigen value and Eigen vectors-Frequency mode shape -Modal analysis.	4	
SECOND INTERNAL EXAM			
V	Lagrange's equation- Solution to problems using Lagrange's equation.	4	15%
	Vibration of continous systems-Vibrating strings- Longitudinal vibration of rods—Torsional vibration of rods	6	
VI	Transient vibrations- Impulse excitation- Convolution integral.	4	15%
	Introduction to non linear vibrations and random vibrations	3	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME376	Maintenance Engineering	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To enable the student to understand the principles, functions and practices of maintenance activities.
- To develop ability in formulating suitable maintenance strategies to achieve reliable manufacturing system.
- To introduce the different maintenance categories and failure analysis tools.
- To equip with essential system diagnosis techniques so as to identify and take appropriate actions on error symptoms and causes of failures.
- To illustrate the techniques used for maintenance management.
- To empower with the skills to manage a manufacturing system to achieve continuous system availability for production.

Syllabus:

Maintenance – reliability – maintainability – availability – maintenance systems – condition monitoring – monitoring systems – failure analysis – maintenance effectiveness – quality assured maintenance – maintenance planning and scheduling – maintenance organization – maintenance costs – maintenance budgeting – human factor in maintenance – computer-aided maintenance management system – maintenance integration.

Expected outcome:

The students will be able to

i. Understand the relationship of key concepts in reliability engineering and application to maintenance strategies in a manufacturing environment.
ii. Establish maintenance strategies according to system characteristics and design transition programs to implement these strategies.
iii. Manage the manufacturing organization with highest possible availability.

Text Books:

1. Gupta A. K., Reliability, Maintenance and Safety Engineering, University Science Press, New Delhi, 2009.

2. Rao S. S., Reliability-Based Design, McGraw-Hill, Inc, New York, 1992.
3. Srivastava S. K., Maintenance Engineering and Management, S. Chand & Company Ltd., New Delhi, 1998.

4. Venkataraman, Maintenance Engineering and Management, Prentic-Hall of India Pvt. Ltd., New Delhi, 2007.

Reference Books:

1. Davies, Handbook of Condition Monitoring, Chapman & Hall, 1996.

2. Garg M. R., Industrial Maintenance, S. Chand & Co., 1986.

3. Higgins L. R., Maintenance Engineering Hand book, McGraw Hill, 5th Edition, 1988.

4. Mishra R. C. and Pathak K., Maintenance Engineering and Management, PHI Learning Pvt. Ltd., New Delhi, 2009.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Maintenance – basic concepts, purpose, functions and objectives of maintenance.	1	15%
	Principles, benefits and effects of maintenance	1	
	Inter-relationship between productivity, quality, reliability and maintainability – maintenance productivity – quality in maintenance.	1	
	Reliability – basic concepts – bathtub curve – failure rate – mean time before failure.	1	
	System reliability – reliability of series and parallel systems.	1	
	Maintainability – mean time to failure – mean time to repair.	1	
	Availability – inherent, achieved and operational availability – reliability, availability and maintainability (RAM).	1	
II	Maintenance strategies / systems – types – basis for selection. Breakdown maintenance – corrective maintenance	1	15%
	Preventive maintenance – process flow – frequency in preventive maintenance.	1	
	Predictive maintenance – components – advantages and disadvantages.	1	
	Condition based maintenance and condition monitoring – monitoring systems.	1	
	Performance monitoring – visual, tactile and aural monitoring – leakage monitoring.	1	
	Temperature monitoring – thermography – advantages.	1	
	Thickness monitoring – acoustic monitoring – smell/odour monitoring.	1	
FIRST INTERNAL EXAMINATION			
III	Vibration monitoring – vibration fundamentals – vibration analysis.	1	15%
	Vibration transducers – types.	1	
	Machinery vibration trouble shooting – machinery vibration standard, severity chart and acceptable limits.	1	
	Lubricant monitoring – components and techniques – filter debris analysis & filtergrams.	1	
	Ferrography – spectroscopic oil analysis program.	1	

	Crack monitoring – techniques.	**1**	
	Corrosion monitoring – techniques.	**1**	
IV	Reliability centered maintenance (RCM) – steps – flow diagram – basic guidelines.	**1**	**15%**
	Defect and failure – definitions – basics of failures – failure generation – failure analysis.	**1**	
	Fault tree analysis (FTA)	**1**	
	Event tree analysis (ETA)	**1**	
	Root cause analysis (RCA)	**1**	
	Failure modes and effects analysis (FMEA)	**1**	
	Failure mode effect criticality analysis (FMECA)	**1**	
SECOND INTERNAL EXAMINATION			
V	Terotechnology – definitions – terotechnology system – terotechnology process – strategies.	**1**	**20%**
	Total productive maintenance (TPM) – features –methodology – basic systems of TPM – TPM and terotechnology.	**1**	
	Six sigma maintenance.	**1**	
	Lean maintenance – 5-zero maintenance concept – 5-S maintenance concept.	**1**	
	Business centered maintenance (BCM) – six pillars – success factors.	**1**	
	Maintenance effectiveness – overall equipment effectiveness – key performance indicators – maintenance performance measuring indices.	**1**	
	Quality assured maintenance – need – maintenance work quality – use of c-chart for quality control in maintenance.	**1**	
VI	Maintenance planning and scheduling.	**1**	**20%**
	Maintenance organization – objectives and characteristics – centralized and decentralized maintenance.	**1**	
	Maintenance costs – classification of maintenance costs – maintenance cost analysis – cost effectiveness analysis.	**1**	
	Maintenance budgeting – types of maintenance budget – preparation of maintenance budget.	**1**	
	Human factor in maintenance – manpower planning for maintenance – objectives and stages of manpower planning – training for maintenance personnel.	**1**	
	Computer-aided maintenance management system (CMMS) – functions, applications and advantages of CMMS.	**1**	
	Maintenance integration – various steps in integration – scheme of integration of maintenance function with other functions.	**1**	

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

SYLLABUS

SEMESTER 7

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME401	DESIGN OF MACHINE ELEMENTS - I	3-1-0-4	2016

Prerequisite: ME201 Mechanics of Solids

Course Objectives:

- To review concepts of statics and strength of materials.
- To introduce fundamental approaches to failure prevention of components.
- To provide knowledge in the design of common machine elements such as fasteners, shafts, springs cotter joints and couplings.

Syllabus

Introduction to Design, Materials and their properties, Theories of Failure, Shock and impact loads,Threaded Joints, Bolted joints, Design of riveted joints, Cotter and Knuckle joints, Design of welded joints, Helical springs, Leaf springs, Shafting, Design of Coupling.

Expected outcome:

The students will be able to

i. Find out various stresses induced in a machine element under different type of loading conditions.
ii. Devise machine components for its conceptual design.

Text Books:

1. Jalaludeen , Machine Design, Anuradha Publications, Chennai,2014
2. R. L. Norton, Machine Design – An Integrated Approach, Pearson Education, 2001
3. V.B.Bhandari, Design of Machine elements, McGraw Hill, 2010

Data books permitted for reference in the final examination:

1. K. Mahadevan, K.Balaveera Reddy, Design Data Hand Book, CBS Publishers & Distributors, 2013
2. NarayanaIyengar B.R & Lingaiah K, Machine Design Data Handbook, Tata McGraw Hill/Suma Publications, 1984
3. PSG Design Data, DPV Printers, Coimbatore, 2012

References Books:

1. J. E. Shigley, Mechanical Engineering Design, McGraw Hill,2003
2. Juvinall R.C & Marshek K.M., Fundamentals of Machine Component Design, John Wiley,2003
3. M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education, 2006
4. Rajendra Karwa, Machine Design, Laxmi Publications,2006

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Introduction to Design- Definition, steps in design process, preferred numbers, standards and codes in design	4	15%
	Materials and their properties- Elastic and plastic behaviour of metals, ductile and brittle behaviour, shear, bending and torsional stresses, combined stresses, stress concentration factor.	5	
II	Theories of Failure- Guest's Theory, Rankine's Theory, St. Venant's Theory, Haigh's Theory, and Von Mises and Hencky Theory.	5	15%
	Shock and impact loads, fatigue loading, endurance limit stress, factors affecting endurance limit, factor of safety	6	
FIRST INTERNAL EXAM			
III	Threaded Joints- Terminology, thread standards, types of threads, stresses in screw threads	3	15%
	Bolted joints- effect of initial tension, eccentric loading, design of bolts for static and fatigue loading, gasketed joints, power screws	4	
IV	Design of riveted joints- Material for rivets, modes of failure, efficiency of joint, design of boiler and tank joints, structural joints	4	15%
	Cotter and Knuckle joints- Gib and Cotter Joint, analysis of knuckle joint.	4	
	Design of welded joints- welding symbols, stresses in fillet and butt welds, Butt joint in tension, fillet weld in tension, fillet joint under torsion, fillet wed under bending, eccentrically loaded welds.	4	
SECOND INTERNAL EXAM			
V	Springs- classification, spring materials, stresses and deflection of helical springs, axial loading, curvature effect, resilience, static and fatigue loading, surging, critical frequency, concentric springs, end construction.	5	20%
	Leaf springs- Flat springs, semi elliptical laminated leaf springs, design of leaf springs, nipping	4	
VI	Shafting- material, design considerations, causes of failure in shafts, design based on strength, rigidity and critical speed, design for static and fatigue loads, repeated loading, reversed bending	5	20%
	Design of Coupling- selection, classification, rigid and flexible coupling, design of keys and pins	3	
END SEMESTER EXAM			

Question paper pattern

Use of approved data book permitted

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 3 questions from module I and II and at least 1 question from each module
Each question carries 15 marks
Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part B
There should be 3 questions from module III and IV and at least 1 question from each module
Each question carries 15 marks
Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part C
There should be 3 questions from module V and VI and at least 1 question from each module
Each question carries 20 marks
Students will have to answer any 2 questions out of 3 (2X20 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME403	ADVANCED ENERGY ENGINEERING	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

1. To give an idea about global energy scenario and conventional energy sources
2. To understand solar, wind and Biomass energy
3. To know concepts of other renewable energy sources
4. To create awareness on the impacts of energy conversion and importance of sustainable energy

Syllabus

Global and Indian energy scenario, conventional energy sources, environmental effect of energy conversion, renewable energy sources- solar, wind, biomass, brief account of other renewable energy sources –geothermal, tidal, MHD, hydrogen, fuel cells, small scale hydro power plants. Environmental impact and Sustainability issues.

Expected outcome:

The students will be able to

i. Understand energy scenario and the environmental effects of energy conversion.

ii. Become aware of different renewable energy sources and choose sustainable energy for

Text Books:

1. Jefferson W Tester et.al., Sustainable Energy: Choosing Among Options, PHI, 2006
2. P K Nag, Power Plant Engineering, TMH, 2002
3. Tiwari G N, Ghosal M K, Fundamentals of renewable energy sources, Alpha Science International Ltd., 2007

References Books:

1. David Merick, Richard Marshall, Energy, Present and Future Options, Vol.I & II, John Wiley & Sons, 2001
2. Godfrey Boyle, Renewable Energy : Power for a Sustainable Future, Oxford University Press, 2012
3. Roland Wengenmayr, Thomas Buhrke, 'Renewable Energy: Sustainable energy concepts for the future, Wiley – VCH, 2012
4. Twidell J W and Weir A D, Renewable Energy Resources, UK, E&F.N. Spon Ltd., 2006

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to the course. Global and Indian energy resources. Energy Demand and supply. Components, layout and working principles of steam, hydro, nuclear, gas turbine and diesel power plants	7	15%
II	Solar Energy- passive and active solar thermal energy, solar collectors, solar thermal electric systems, solar photovoltaic systems. Economics of solar power. Sustainability attributes.	7	15%
FIRST INTERNAL EXAM			

III	Wind Energy-Principle of wind energy conversion system, wind data and energy estimation, wind turbines, aerodynamics of wind turbines, wind power economics. Introduction to solar-wind hybrid energy systems	7	15%
IV	Biomass Energy – Biomass as a fuel, thermo-chemical, bio-chemical and agro-chemical conversion of biomass- pyrolysis, gasification, combustion and fermentation, transesterification, economics of biomass power generation, future prospects.	6	15%
SECOND INTERNAL EXAM			
V	Other Renewable Energy sources – Brief account of Geothermal, Tidal , Wave, MHD power generation, Small, mini and micro hydro power plants. Fuel cells – general description, types, applications. Hydrogen energy conversion systems, hybrid systems- Economics and technical feasibility	8	20%
VI	Environmental impact of energy conversion – ozone layer depletion, global warming, greenhouse effect, loss of biodiversity, eutrophication, acid rain, air and water pollution, land degradation, thermal pollution, Sustainable energy, promising technologies, development pathways	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME 405	REFRIGERATION AND AIR CONDITIONING	2-1-0-3	2016

Prerequisite: ME205 Thermodynamics

Course Objectives:

1. To introduce vapour compression and vapour adsorption systems
2. To impart knowledge on refrigeration cycles and methods to improve performance
3. To familiarize the components of refrigeration systems
4. To introduce air conditioning systems
5. To know the applications of refrigeration and air conditioning systems

Syllabus

Introduction, Thermodynamics of refrigeration, Air refrigeration systems, Vortex tube refrigeration, Adiabatic demagnetization of paramagnetic salts, Vapour compression systems, Refrigerants and their properties, Application of refrigeration, Refrigeration system components, Air conditioning, Psychrometry, Air conditioning systems.

Expected outcome:

The students will be able to

i. Understand the principles refrigeration of air-conditioning and basic design considerations.
ii. Carry out analysis of refrigeration cycles
iii. Apply the concepts of indoor environmental comfort.
iv. Perform psychrometric calculations, humidity control and analysis of air-conditioning processes
v. Know the various applications of Refrigeration and air conditioning

Text Books:

1. Arora C. P, Refrigeration and Air-Conditioning, McGraw-Hill, 2008
2. Arora S. C. and Domkundwar, Refrigeration and Air-Conditioning, Dhanpat Rai, 2010
3. Ballaney P. L, Refrigeration and Air-Conditioning, Khanna Publishers, New Delhi, 2014
4. Manohar Prasad, Refrigeration and Air-Conditioning, New Age International, 2011

References Books:

1. ASHRAE Handbook
2. Dossat. R. J, Principles of Refrigeration, Pearson Education India, 2002
3. Stoecker W.F, Refrigeration and Air-Conditioning, McGraw-Hill Publishing Company, 2009

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction – Brief history and applications of refrigeration. Thermodynamics of refrigeration- reversed Carnot cycle- heat pump and refrigeration machines, Limitations of reversed Carnot cycle. Unit of refrigeration- Air refrigeration systems- Reversed Joule cycle, Air craft refrigeration systems, simple bootstrap- Regenerative and reduced ambient system	6	15%

II	Vortex tube refrigeration-Very low temperature refrigeration systems (concept only). Adiabatic demagnetization of paramagnetic salts Vapour compression systems-simple cycle - representation on T- s and P- h Diagrams. COP- Effect of operating parameters on COP – methods of improving COP of simple cycle- super- heating , under cooling, Liquid suction heat exchanger, actual cycle.	8	15%
FIRST INTERNAL EXAM			
III	Multi pressure systems - multi compression and multi evaporator, systems. Inter cooling - flash inter cooling and flash gas removal- Different combinations of evaporator and compressor for different applications, Cascade system Refrigerants and their properties-Eco-friendly Refrigerants, mixed refrigerants, selection of refrigerants for different applications Vapour absorption systems - Ammonia – water system - simple system- drawbacks-Lithium Bromide water system- Electrolux-comparison with vapour compression system- steam jet refrigeration.	7	15%
IV	Application of refrigeration- domestic refrigerators- water coolers-ice plants. Cold storages- food preservation methods- plate freezing , quick-freezing. Refrigeration system components- Compressors, condensers, expansion devices, evaporators. Cooling towers- Different types and their application fields- Refrigerant leakage and detection – charging of refrigerant – system controls.	6	15%
SECOND INTERNAL EXAM			
V	Air conditioning – meaning and utility, comfort and industrial air conditioning. Psychometric properties- saturated and unsaturated air, dry, wet and dew point temperature – humidity, specific humidity, absolute humidity, relative humidity and degree of saturation-thermodynamic equations- enthalpy of moisture- adiabatic saturation process -psychrometers. Thermodynamic wet bulb temperature, psychometric chart- Psychometric processes- adiabatic mixing-sensible heating and cooling- humidifying and dehumidifying, air washer – bypass factor- sensible heat factor-RSHF and GSHF line-Design condition- Apparent dew point temperature – Choice of supply condition, state and mass rate of dehumidified air quantity – Fresh air supplied –air refrigeration. Comfort air conditioning- factors affecting human comfort. Effective temperature – comfort chart. Summer air conditioning- factors affecting-cooling load estimation.	8	20%
VI	Air conditioning systems- room air conditioner- split system-packaged system-all air system-chilled water system. Winter air conditioning – factors affecting heating system, humidifiers. Year round air conditioning AC system controls-thermostat and humidistat. Air distribution systems- duct system and design- Air conditioning of restaurants, hospitals, retail outlets, computer center, cinema theatre, and other place of amusement. Industrial applications of air conditioning.	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Use of approved Refrigerant tables permitted

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME407	MECHATRONICS	3-0-0- 3	2016

Prerequisite: Nil

Course Objectives:

- To introduce the features of various sensors used in CNC machines and robots
- To study the fabrication and functioning of MEMS pressure and inertial sensors
- To enable development of hydraulic/pneumatic circuit and PLC programs for simple applications

Syllabus

Introduction to Mechatronics, sensors, Actuators, Micro Electro Mechanical Systems (MEMS), Mechatronics in Computer Numerical Control (CNC) machines, Mechatronics in Robotics-Electrical drives, Force and tactile sensors, Image processing techniques, Case studies of Mechatronics systems.

Expected outcome:

The students will be able to

i. Know the mechanical systems used in mechatronics
ii. Integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems

Text Books:

1. Bolton W., Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Person Education Limited, New Delhi, 2007
2. Ramachandran K. P., G. K. Vijayaraghavan, M. S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Wiley India Pvt. Ltd., New Delhi, 2008.
3. Saeed B. Niku, Introduction to Robotics: Analysis, Systems, Applications, Person Education, Inc., New Delhi, 2006.

References Books:

1. David G. Aldatore, Michael B. Histand, Introduction to Mechatronics and Measurement Systems, McGraw-Hill Inc., USA, 2003.
2. Gordon M. Mair, Industrial Robotics, Prentice Hall International, UK, 1998.
3. HMT, Mechatronics, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
4. Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan, Smart Material Systems and MEMS: Design and Development Methodologies, John Wiley & Sons Ltd., England, 2006.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Mechatronics: Structure of Mechatronics system. Sensors - Characteristics -Temperature, flow, pressure sensors. Displacement, position and proximity sensing by magnetic, optical, ultrasonic, inductive, capacitive and eddy current methods. Encoders: incremental and absolute, gray coded encoder. Resolvers and synchros. Piezoelectric sensors. Acoustic Emission sensors. Principle and types of vibration sensors.	8	15%

II	Actuators: Hydraulic and Pneumatic actuators - Directional control valves, pressure control valves, process control valves. Rotary actuators. Development of simple hydraulic and pneumatic circuits using standard Symbols.	7	15%
FIRST INTERNAL EXAM			
III	Micro Electro Mechanical Systems (MEMS): Fabrication: Deposition, Lithography, Micromachining methods for MEMS, Deep Reactive Ion Etching (DRIE) and LIGA processes. Principle, fabrication and working of MEMS based pressure sensor, accelerometer and gyroscope.	6	15%
IV	Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines - Mechatronics elements - Machine structure: guide ways, drives. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws, pre-loading methods. Re-circulating roller screws. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools. Programmable Logic Controllers (PLC) –Basic structure, input/ output processing. Programming: Timers, Internal Relays, Counters and Shift registers. Development of simple ladder programs for specific purposes.	8	15%
SECOND INTERNAL EXAM			
V	System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems. Mechatronics in Robotics-Electrical drives: DC, AC, brushless, servo and stepper motors. Harmonic drive. Force and tactile sensors. Range finders: ultrasonic and light based range finders	6	20%
VI	Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras. Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding. Case studies of Mechatronics systems: Automatic camera, bar code reader, pick and place robot, automatic car park barrier system, automobile engine management system.	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II. Each question carries 10 marks. Students will have to answer any three questions out of 4 (3X10 =30 marks)

Part B

There should be 2 questions each from module III and IV. Each question carries 10 marks. Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI. Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME409	COMPRESSIBLE FLUID FLOW	2-1-0-3	2016

Prerequisite: ME205 Thermodynamics

Course Objectives:

- To familiarize with behavior of compressible gas flow.
- To understand the difference between subsonic and supersonic flow
- To familiarize with high speed test facilities

Syllabus

Introduction to Compressible Flow, Wave propagation, One dimensional steady isentropic flow, Irreversible discontinuity in supersonic flow, Flow in a constant area duct with friction (Fanno Flow), Flow through constant area duct with heat transfer (Rayleigh Flow), Compressible flow field visualization and measurement, measurement in compressible flow, Wind tunnels

Expected outcome:

The students will be able to

i. Formulate and solve problems in one -dimensional steady compressible flow including: isentropic nozzle flow, constant area flow with friction (Fanno flow) and constant area flow with heat transfer (Rayliegh flow).
ii. Derive the conditions for the change in pressure, density and temperature for flow through a normal shock.
iii. Determine the strength of oblique shock waves on wedge shaped bodies and concave corners
iv. Know the various measuring instruments used in compressible flow

Data book/Gas tables:

1. Yahya S. M., Gas Tables**,** New Age International, 2011
2. Balachandran P., Gas Tables, Prentice-Hall of India Pvt. Limited, 2011

Text Books:

1. Balachandran P., Fundamentals of Compressible Fluid Dynamics, PHI Learning. 2006
2. Rathakrishnan E., Gas Dynamics, PHI Learning, 2014
3. Yahya S. M., Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, New Age International Publishers, 2003

References Books:

1. Anderson**,** Modern compressible flow, 3e McGraw Hill Education, 2012
2. Shapiro, Dynamics and Thermodynamics of Compressible Flow – Vol 1., John Wiley & Sons,1953

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Introduction to Compressible Flow- Concept of continuum-system and control volume approach- conservation of mass, momentum and energy- stagnation state- compressibility-Entropy relations. Wave propagation- Acoustic velocity-Mach number-effect of Mach number on compressibility- Pressure coefficient-physical difference between incompressible, subsonic, sonic and supersonic flows- Mach cone-Sonic boom-Reference velocities- Impulse function-adiabatic energy equation-representation of various flow regimes on steady flow adiabatic ellipse.	8	15%
II	One dimensional steady isentropic flow- Adiabatic and isentropic flow of a perfect gas- basic equations- Area-Velocity relation using 1D approximation-nozzle and diffuser-mass flow rate-chocking in isentropic flow-flow coefficients and efficiency of nozzle and diffuser- working tables-charts and tables for isentropic flow-operation of nozzle under varying pressure ratios –over expansion and under expansion in nozzles.	7	15%
FIRST INTERNAL EXAM			
III	Irreversible discontinuity in supersonic flow- one dimensional shock wave- stationary normal shock- governing equations- Prandtl- Meyer relations- Shock strength- Rankine- Hugoniot Relation- Normal Shock on T-S diagram- working formula- curves and tables-Oblique shock waves - supersonic flow over compression and expansion corners (basic idea only).	7	15%
IV	Flow in a constant area duct with friction (Fanno Flow) – Governing Equations- Fanno line on h-s and P-v diagram- Fanno relation for a perfect gas- Chocking due to friction- working tables for Fanno flow- Isothermal flow(elementary treatment only)	6	15%
SECOND INTERNAL EXAM			
V	Flow through constant area duct with heat transfer (Rayleigh Flow)-Governing equations- Rayleigh line on h-s and P-v diagram-Rayleigh relation for perfect gas- maximum possible heat addition-location of maximum enthalpy point- thermal chocking- working tables for Rayleigh flow.	6	20%
VI	Compressible flow field visualization and measurement-Shadowgraph-Schlieren technique- interferometer- subsonic compressible flow field -measurement (Pressure, Velocity and Temperature) – compressibility - correction factor- hot wire anemometer- supersonic flow measurement- Shock tube-Rayleigh Pitot tube- wedge probe- stagnation temperature probe- temperature recovery factor –Kiel probe - Wind tunnels – closed and open type-	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Use of approved gas tables permitted

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
**451	Seminar and Project Preliminary	0-1-4-2	2016
Prerequisite : Nil			

Course Objectives

- To develop skills in doing literature survey, technical presentation and report preparation.
- To enable project identification and execution of preliminary works on final semester project

Course Plan

Seminar: Each student shall identify a topic of current relevance in his/her branch of engineering, get approval of faculty concerned, collect sufficient literature on the topic, study it thoroughly, prepare own report and present in the class.

Project preliminary:

Identify suitable project relevant to the branch of study. Form project team (not exceeding four students). The students can do the project individually also. Identify a project supervisor. Present the project proposal before the assessment board (excluding the external expert) and get it approved by the board.

The preliminary work to be completed: (1) Literature survey (2) Formulation of objectives (3) Formulation of hypothesis/design/methodology (4) Formulation of work plan (5) Seeking funds (6) Preparation of preliminary report

Note: The same project should be continued in the eighth semester by the same project team.

Expected outcome.

The students will be able to

i. Analyse a current topic of professional interest and present it before an audience
ii. Identify an engineering problem, analyse it and propose a work plan to solve it.

Evaluation

Seminar : **50 marks**

(Distribution of marks for the seminar is as follows: i. Presentation : 40% ii. Ability to answer questions : 30% & iii. Report : 30%)

Project preliminary : **50 marks**(Progress evaluation by the supervisor : 40% and progress evaluation by the assessment board excluding external expert : 60%. Two progress evaluations, mid semester and end semester, are mandatory.)

Note: All evaluations are mandatory for course completion and for awarding the final grade.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME431	MECHANICAL ENGINEERING LAB.	0-0-3-1	2016

Prerequisite : ME302 Heat and mass transfer, ME304 Dynamics of machinery

Course Objectives:

- To conduct the various heat transfer experiments
- To practice calibration of thermometer and pressure gauges
- To do experiments on dynamics

Syllabus

List of experiments:

Hear transfer

1. Determination of LMTD and effectiveness of parallel flow, Counter flow and cross flow heat exchangers(double pipe heat exchanger)
2. Determination of heat transfer coefficients in free convection(free convection apparatus)
3. Determination of heat transfer coefficients in forced convection (forced convection apparatus)
4. Determination of thermal conductivity of solids(composite wall)
5. Determination of thermal conductivity of powder
6. Determination of Thermal conductivity of liquids
7. Determination of emissivity of a specimen (emissivity apparatus)
8. Determination of Stefan Boltzman constant (Stefan Boltzmann apparatus)
9. Study and performance test on refrigeration (Refrigeration Test rig)
10. Study and performance test air conditioning equipment(air conditioning test rig)
11. Performance study on heat pipe(Heat pipe)
12. Calibration of Thermocouples
13. Calibration of Pressure gauge

Dynamics

14. Whirling of shaft
15. Gyroscope
16. Universal governor apparatus
17. Free vibration analysis
18. Forced vibration analysis

Note: Minimum 9 experiments in heat transfer and 3 experiments in dynamics are mandatory

Expected outcome:

The students will be able to

1. Conduct experiments to determine thermal conductivity of materials
2. Determine heat transfer coefficient, LMTD etc..
3. Do calibration of thermometers and pressure gauges
4. Demonstrate the effect of unbalances resulting from rotary motions
5. Visualise the effect of dynamics on vibrations in single and multi degree of freedom system
6. Demonstrate the working principle of governor /gyroscope and demonstrate the effect of forces and moments on their motion

SYLLABUS

Elective 3

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME461	Aerospace Engineering	3-0-0-3	2016

Prerequisite : Nil

Course Objectives: :

- To understand the fundamentals of aerospace engineering
- To provide an understanding of flight instruments

Syllabus:

The atmosphere, airfoil theory, 2D, 3D or Finite aero foils Propellers, Aircraft performance, Flight Instruments, stability of aircrafts, wind tunnel testing

Expected Outcomes:

The students will be able to

i. Identify, formulate and solve aerospace engineering problems
ii. Perform analysis of flight dynamics of aircrafts

Text books:

1. A.C. Kermode, Mechanics of flight, Prentice Hall, 2007
2. Anderson, Fundamentals of Aerodynamics, McGraw-Hill, 2010
3. EHJ Pallett, Aircraft Instruments and Integrated systems, Longman,1992

Reference books:

1. Houghton and brock, Aerodynamics for Engineering Student, Hodder & Stoughton,1977

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	The atmosphere-characteristics of troposphere , stratosphere , thermosphere, and ionosphere- pressure, temperature and density variations in the atmosphere. Application of dimensional analysis – aerodynamic force – model study and similitude. 2D aero foils -Nomenclature and classification- pressure distribution in inviscid and real flows- momentum and circulation theory of aerofoil- characteristics.	8	15%
II	3D or Finite aero foils – effect of releasing the wingtips- wing tip vortices- replacement of finite wing by horse shoe vertex system, lifting line theory-wing load distribution – aspect ratio, induced drag calculation of induced drag from momentum considerations. Skin friction and from drag- changes in finite wing plan shape	7	15%
FIRST INTERNAL EXAMINATION			

III	Propellers – momentum and blade element theories –propeller coefficients and charts. Aircraft performance-straight and level flight –power required and power available graphs for propeller and jet aircraft	**6**	**15%**
IV	Gliding and climbing –rate of climb-service and absolute ceilings-gliding angle and speed of flattest glide takeoff and landing performance – length of runway required- aircraft ground run- circling flight – radius of tightest turn-jet and rocket assisted take –off high lift devices-range and endurance of airplanes-charts for piston and jet engine aircrafts.	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Flight Instruments-airspeed indicator, calculation of true air speed-altimeter, gyrohorizon -direction indicator-vertical speed indicator –turn and back indicator-air temperature indicator. (Brief description and qualitative ideas only). Ideas on stability-static and dynamic stability- longitudinal, lateral and directional stability- controls of an aero plane- aerodynamic balancing of control surfaces- mass balancing (Qualitative ideas only).	**7**	**20%**
V1	Principles of wind tunnel testing –open and closed type wind tunnels-wind tunnel balances supersonic wind tunnels. Study of subsonic, Transonic, and supersonic aircraft engines (Description with figures Only).Elementary ideas on space travel-calculation of earth orbiting and escape velocities ignoring air resistance and assuming circular orbit.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME463	Automobile Engineering	3-0-0-3	2016

Pre requisites: Nil

Course objectives

- To know the anatomy of automobile in general
- To understand the working of different automotive systems and subsystems
- To update the latest developments in automobiles

Syllabus:- Engine, clutch, transmission, steering, brakes, suspension and aerodynamics

COURSE OUTCOMES:

The students will be able to:

i. Practically identify different automotive systems and subsystems.

ii. Understand the principles of transmission, suspension, steering and braking systems of an automobile

iii. Develop a strong base for understanding future developments in the automobile industry

Text Books

1. Gupta R.B. Auto design , Satya Prakash, New Delhi, 2015
2. Heinz Heisler, Advanced engine technology, Butterworth-Heinemann,1995
3. Heinz Heisler, Advanced vehicle technology, Society of Automotive Engineers Inc, 2002
4. Hillier and Peter Coobes, Fundamentals of motor vehicle technology, Nelson Thornes, 2004
5. Tom Denton, Automobile mechanical and electrical systems, Butterworth-Heinemann, 2011

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Piston: - material for piston, clearances, piston rings, types, need for two compression rings, oil control ring, piston pin.	1	15%
	Piston for IC engine, piston rings, piston pin, connecting rod, crank shaft, crank pin, cam shaft, valves, fly wheel, fluctuation of energy and size of fly wheel, hub and arms, stress in a fly wheel rim, simple problems.	1	
		1	
	Petrol fuel injection systems: - comparison petrol injection and carbureted fuel supply systems- comparison –multiport fuel injection (MPFI) and common rail direct injection (CRDI) systems.	1	
		1	
	Super charging systems: fundamentals, naturally aspirated engines and supercharged engines– Turbo charger, turbo lag.	1	

	Hybrid cars, safety overview -Formula-I engine technology: overview, electrical technology, brakes, transmission technology.	1	
II	Friction clutch:- fundamentals, driven plate inertia, driven plate transmitted torque, driven plate wear –angular driven plate cushioning and torsional damping, clutch friction materials, when clutch is worn out.	1	**15%**
	Pull type diaphragm clutch, multiple diaphragm clutch, multi-plate hydraulically operated automatic transmission clutch, semi centrifugal clutch, fully automatic centrifugal clutch, and integral single plate diaphragm clutch.	1	
		1	
	Need of gear box, resistance to vehicle motion, power to weight ratio, speed operating range-five speed and reverse sliding mesh, constant mesh, and synchromesh gear boxes:- gear synchronization and engagement.	1	
		1	
	Over drives – hydrodynamic fluid couplings: - efficiency and torque capacity – fluid friction coupling- torque converters.	1	
		1	
FIRST INTERNAL EXAMINATION			
III	Steering:-basic principle of a steering system:- swinging beam system – Ackermann –over steer and under steer – slip angle, camber, caster etc.	1	**15%**
		1	
	Swivel axis inclination: centre point steering, camber, king pin inclination, negative offset, caster, toe-in and toe-out	1	
	Steering gear box: - fundamentals screw and nut steering gear mechanism-worm and roller type steering gear box – Re-circulating ball nut and rocker lever, re-circulating ball rack and sector steering gear box– need of power assisted steering.	1	
		1	
		1	
	External direct coupled and rack and pinion and integrated steering power cylinder, power assisted steering lock limitations	1	
IV	Suspension: - suspension geometry, terminology- Macpherson strut friction and spring offset - suspension roll centers:-roll centers, roll axis, roll centre height, short swing and long arm suspension, transverse double wishbone, parallel trailing double arm and vertical pill strut suspension, Macpherson strut suspension, semi-trailing arm rear suspension, telescopic suspension.	1	**15%**
		1	
	High load beam axle leaf spring, sprung body roll stability. Rear axle beam suspension- body roll stability analysis:- body roll couple, body roll stiffness, body over turning couple	1	

	Body weight transfer, body direct weight transfer couple, body roll couple distribution, body roll weight transfer, lateral force distribution.	1	
	Anti roll bars and roll stiffness:- anti roll bar function, operating principle, anti roll bar action caused by the body rolling, single wheel lift -rubber spring bumper:-bump stop function and characteristics, axis inclination.	1	
	Rear suspension: - live rigid axle suspension, non drive rear suspension- swing arm rear wheel drive independent suspension.	1	
	Low pivot split axle coil spring wheel drive independent suspension, trailing and semi trailing arm rear wheel drive independent suspension.	1	**15%**
	Transverse double link arm rear wheel drive independent suspension, De Dion axle rear wheel suspension - Hydrogen suspension, hydro-pneumatic automatic height correction suspension.	1	
SECOND INTERNAL EXAMINATION			
V	Brakes:- mechanical and hydraulic brakes (review only) – properties of friction lining and pad materials, efficiency, stopping distance, theory of internal shoe brake, equations –	1	**20%**
	effect of expanding mechanism of shoes on total braking torque, equations.	1	
	Braking vehicles:- brakes applied on rear, front and all four wheels, equations –calculation of mean lining pressure and	1	
	heat generation during braking operation, equations. – braking of vehicle moving on curved path, simple problems.	1	
	Anti Lock Braking system (ABS):- need and advantages of ABS – hydro-mechanical ABS - hydro-electric ABS - air-electric ABS.	1	
	Brake servos: - operating principle, vacuum servo - direct acting suspended vacuum assisted brake servo unit operation - hydraulic servo assisted brake systems.	1	
	Pneumatic operated disc brakes – air operated brake systems: - air over hydraulic brake system - Three line brake system-– electronic-pneumatic brakes.	1	
V1	Aerodynamic drag: pressure drag, air resistance, opposing motion of a vehicle, equations, after flow wake, drag	1	**20%**
	coefficients, various body shapes, base drag, vortices, trailing vortex drag, attached transverse vortices.	1	
	Aerodynamic lift:-lift coefficients, vehicle lift, underbody floor height versus aerodynamic lift and drag, aerofoil lift	1	
	and drag, front end nose shape.	1	
	Car body drag reduction:-profile edge chamfering, bonnet	1	

	slope and wind screen rake, roof and side panel chamfering, rear side panel taper, underbody rear end upward taper, rear end tail extension, underbody roughness.		
	Aerodynamic lift control:- underbody dams, exposed wheel air flow pattern, partial enclosed wheel air flow pattern, rear end spoiler, negative lift aerofoil wings.	1	
	After body drag: - square back drag, fast back drag, hatch back drag, notch back drag.	1	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME465	Industrial Hydraulics	3-0-0-3	2016

Prerequisite : Nil

Course Objectives: :

1. To introduce various fluid power systems
2. To get knowledge on fluid power circuits

Syllabus:

Introduction to fluid power, Properties of fluids. Selection of fluids, Pumps, Hydraulic cylinders and rams, Fluid power pumping systems and components, Hydraulic Actuators, Fluid temperature control, Piping systems, Control circuits

Expected Outcomes:

The students will be able

1. To understand the various components used in fluid power systems
2. To select the suitable system for a particular application
3. To know the various fluid circuits used in hydraulic systems

Text books:

1. B. Lall, Oil Hydraulics, International Literature Association
2. D. A. Pease, Basic Fluid Power, Prentice Hall,1986
3. J. J. Pipenger, Tyler Gregory Hicks, Industrial Hydraulics, McGraw Hill,1979
4. Pinches, Industrial Fluid Power, Prentice Hall,1989
5. R.K. Bansal, Fluid Mechanics, Laxmi Publication (P) Ltd.,2017

Reference:

1. ISO - 1219, Fluid Systems and components, Graphic Symbols
2. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier ,1999
3. Michael J. Prinches and Ashby J. G, Power Hydraulics, Prentice Hall,1988
4. Yeaple, Fluid Power Design Handbook, CRC Press,1995

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to fluid power – Hydraulics and Pneumatics systems – Fluid power systems – Fundamentals of fluid mechanics , Properties of fluids. Selection of fluids, additives, effect of temperature and pressure on hydraulic fluids , Measurement of physical parameters – Hydraulic symbols	7	15%
II	Pumps: Types , classification , principle of working & constructional details of vane pump, gear pumps, radial and axial plunger pumps, Power and efficiency calculations, char, Curves, selection of pumps for hydraulic power transmission	7	15%
FIRST INTERNAL EXAMINATION			

III	Hydraulic cylinders and rams – Fluid power pumping systems and components. Pressure accumulators – Functions – Fluid reservoirs – Filter in hydraulic circuits. Loading and replacement of filter elements – Materials for filters.	**7**	**15%**
IV	Hydraulic Actuators (i) Linear and Rotary. (ii) Hydraulic motors - Types- Vane, Gear, Piston types, radial piston. (iii) Methods of control of acceleration, deceleration. (iv) Types of cylinders and mountings. (v) Calculation of piston velocity, thrust under static and dynamic applications, considering friction, inertia loads. (vi) Design considerations for cylinders. Cushioning of cylinders.	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Fluid temperature control – Fluid pressure control –control valves – Sequence -valve – Counterbalance valve-unloading valve – Friction control valve – Servo systems, Hoses & Pipes : Types , materials , pressure drop in hoses/pipes. Hydraulic piping connections.	**7**	**20%**
V1	Simple reciprocating, Regenerative, Speed control (Meter in, Meter out and bleed off), Sequencing, Synchronization, transverse and feed, circuit for riveting machine, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, circuit for hydraulic press, unloading circuit (Numerical treatment), motor breaking circuit	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P	Credits	Year of Introduction
IE306	SUPPLY CHAIN AND LOGISTICS MANAGEMENT	3-0-0	3	2016

Prerequisite: Nil

Course Objectives

- To develop knowledge on structures, decision phases, measures and tools of supply chains.
- To develop understanding on the strategic, tactical and operational decision tools of supply chains.
- To impart knowledge on logistics management and related advanced tools and techniques.

Syllabus

General features of supply chains, planning demand and supply, forecasting, aggregate planning, network design, locations, layouts etc. Supply chain inventory planning decisions, multi-echelon cycle and safety inventory systems: Logistics management: design of transportation network. Routing, scheduling and sequencing. Advanced logistics decision models.

Expected Outcome

The students will

i. Understand the structures, decision phases, measures and tools of supply chains.
ii. Understand the strategic, tactical and operational decision tools of supply chains.
iii. Understand knowledge on logistics management and related advanced tools and techniques.

Text Books

1. G. Sreenivasan, Quantitative Models in Operations and Supply Chain Management, PHI
2. Sunil Chopra, Peter Meindl, Supply Chain Management – Strategy, Planning and Operation, Pearson Education.

References

1. David Simchi – Levi & Philip Kaminsk, Designing and Managing the Supply Chain, McGraw-Hill Companies Inc.
2. David Taylor and David Brunt, Manufacturing Operations and Supply Chain Management, Vikas Thomson Learning, 2001.
3. Donald J. Bowersox & David J. Closs, Logistical Management, TMH.
4. Jeremy F. Shapiro, Modeling and Supply Chain,. Thomson Learning, 2001.
5. Martin Christopher, Logistics and supply chain management, Financial times management.

COURSE PLAN

Module	Contents	Hours	End-Sem. Exam. Marks
I	**General Features of Supply Chains:** Supply Chains – Structures, Decision Phases, Performance Drivers and Measures, Metrics. Achieving Strategic Fit and its Obstacles.	7	15%

II	**Planning Demand & Supply:** Planning demand and supply in supply chains – Forecasting techniques for supply chains, Seasonal Forecasting Models, Measure of Forecast errors.	**7**	**15%**
FIRST INTERNAL EXAM			
III	**Aggregate Planning:** Aggregate Planning Strategies, Aggregate Planning models - Quantitative Examples. **Network Design, Locations and Layouts:** Network design in Uncertain Environment, Facility Location and Layout decisions.	**7**	**15%**
IV	**Multi-echelon Inventory Systems:** Inventory Planning Decisions –Estimate of Cycle Inventory, Discounting Models, Multi-item Inventory models, Determination of Safety Inventory, Impact of Supply Uncertainty, Multi- echelon Inventory models, Quantitative Examples. Bullwhip effect.	**7**	**15%**
SECOND INTERNAL			
V	**Logistics Management**: 3PL, 4PL, Design Options for Transportation Network. Routing, Scheduling and Sequencing in Transportation, Vehicle Routing Problems. Quantitative Examples.	**7**	**20%**
VI	**Reverse Logistics:** Reverse logistics and Closed Loop Supply Chains. **Advanced Logistics Decision Models:** Bin Packing Problems, Fixed Charge Problems, Knapsack Problems, Multi-stage transportation problems.	**7**	**20%**
END SEMESTER EXAM			

End Semester Examination Question Paper Pattern

Examination duration: 3 hours Maximum Marks: 100

Part A (Modules I and II):
Candidates have to answer any 2 questions from a choice of 3 questions. Each full question carries a total of 15 marks and can have a maximum of 4 sub questions (a, b, c, d). No two questions shall be exclusively from a single module. All three questions shall preferably have components from both modules. Marks for each question/sub question shall be clearly specified. Total percentage of marks for the two modules put together as specified in the curriculum shall be adhered to for all combinations of any two questions.

Part B (Modules III and IV):
(Same as for part A marks)

Part C (Modules V and VI):
(Same as for part A, except that each full question carries 20 marks)

Note: If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME467	Cryogenic Engineering	3-0-0-3	2016

Prerequisite : NIL

Course Objectives: :

- To provide the knowledge of evolution of low temperature science
- To provide knowledge on the properties of materials at low temperature
- To familiarize with various gas liquefaction systems and to provide design aspects of cryogenic storage and transfer lines

Syllabus:

Introduction to Cryogenics, Applications of Cryogenics, Properties of materials at cryogenic temperature, Liquefaction systems, Gas liquefaction systems, Cryogenic Refrigeration systems, Cryogenic fluid storage and transfer systems, Cryogenic instrumentation, heat exchangers used in cryogenic systems

Expected Outcomes:

The students will be able to

i. Understand properties of material at cryogenic temperatures.
ii. Know about various liquefaction systems
iii. Get ideas on cryogenic refrigeration systems, cryogenic instrumentation and cryogenic heat exchangers

Text books

1. J. H. Boll Jr, Cryogenic Engineering
2. R. B. Scott, Cryogenic Engineering, Van Nostrand Co., 1959
3. Randal F.Barron, Cryogenic systems, McGraw Hill, 1986

Reference books:

1. Klaus D.Timmerhaus and Thomas M.Flynn, Cryogenic Process Engineering, Plenum Press, New York, 1989.

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to Cryogenic Systems, Historical development, Low Temperature properties of Engineering Materials, Mechanical properties- Thermal properties- Electric and magnetic properties – Cryogenic fluids and their properties. Applications of Cryogenics: Applications in space, Food Processing, super conductivity, Electrical Power, Biology, Medicine, Electronics and Cutting Tool Industry. Low temperature properties of engineering materials	8	15%
II	Liquefaction systems ideal system, Joule Thomson expansion, Adiabatic expansion, Linde Hampson Cycle, Claude & Cascaded System, Magnetic Cooling, Stirling Cycle Cryo Coolers.	7	15%
FIRST INTERNAL EXAMINATION			

III	Gas liquefaction systems: Introduction-Production of low temperatures-General Liquefaction systems- Liquefaction systems for Neon. Hydrogen and Helium –Critical components of Liquefaction systems	**6**	**15%**
IV	Cryogenic Refrigeration systems: Ideal Refrigeration systems-Refrigeration using liquids and gases as refrigerant- Refrigerators using solids as working media;,	**6**	**15%**
SECOND INTERNAL EXAMINATION			
V	Cryogenic fluid storage and transfer systems: Cryogenic Storage vessels and Transportation, Thermal insulation and their performance at cryogenic temperatures, Super Insulations, Vacuum insulation, Powder insulation, Cryogenic fluid transfer systems.	**8**	**20%**
V1	Cryogenic instrumentation, Pressure flow-level and temperature measurements. Types of heat exchangers used in cryogenic systems(only description with figure) Cryo pumping Applications	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME469	FINITE ELEMENT ANALYSIS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

1. To learn the mathematical background of finite element methods.
2. To understand the basics of finite element formulation.
3. To practice finite element methodologies through structural and heat transfer problems.

Syllabus

Introduction; Brief history; Review of elasticity; Direct approach;1D bar element; Analogous problems; Beam elements; Plane truss; Coordinate transformations; Interpolation functions; Shape functions; Variational methods; Strong and weak form; Rayleigh Ritz method; FE formulation using minimization of potential; Consistent nodal loads; Higher order elements; Iso parametric elements; Weighted residual methods; FEA software packages.

Expected outcome

The students will be able to

i. understand the mathematical background of FEM .
ii. solve real life problems using finite element analysis

Text Books:

1. Chandrupatla T R., Finite Element Analysis for Engineering and Technology, University Press, 2004
2. Hutton D V., Fundamentals of Finite Element Analysis, Tata McGraw-Hill, 2005
3. Logan D L., A first course in the Finite Element Method, Thomson-Engineering, 2012
4. Seshu P., Text Book of Finite Element Analysis, PHI Learning Pvt. Ltd., 2003

References Books:

1. Cook R D., Malkus D S., Plesha M E.,Witt R J., Concepts and Analysis of Finite Element Applications, John Wiley & Sons,1981
2. Reddy J N., An introduction to the Finite Element Method, McGraw- Hill, 2006

Course

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Finite Element Method (FEM)- Brief history- Application of FEA- Advantages and disadvantages. Review of elasticity- Strain displacement relations- Compatibility-Stress strain relations- Boundary conditions- Plane stress, plane strain and axisymmetry.	2	15%

	Direct approach-1D bar element- element stiffness- Assembly of elements- properties of [K] matrix- Treatment of boundary conditions- Stress computation.	4	
II	Analogous problems of torsion, heat conduction and laminar pipe flow. Beam elements- FE formulation-element stiffness matrix- boundary conditions.	4	20%
	Plane truss- Element formulation-Co ordinate transformation- Local and global co ordinates- Stress calculations.	4	
FIRST INTERNAL EXAMINATION			
III	Interpolation functions-Shape functions- Lagrange interpolation- 1D linear and quadratic element	3	15%
	Variational methods: Functionals- Strong and weak form- Essential and natural boundary conditions.	3	
IV	Principle of stationary potential energy- Rayleigh Ritz method.	3	20%
	FE formulation using minimization of potential- B matrix- Element matrices for bar element- Consistent nodal loads.	4	
SECOND INTERNAL EXAMINATION			
V	Higher order elements- Quadratic and cubic elements-Pascal's triangle-Serendipity elements.	3	15%
	Iso parametric elements, Natural coordinates, Area co ordinates-Quadrilateral elements-Jacobian matrix-Gauss quadrature.	5	
VI	Weighted residual method: Galerkin FE formulation. Axially loaded bar-Heat flow in a bar	5	15%
	Structure of FEA software package. Introduction to Modal analysis, non linear analysis and coupled analysis.	2	
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100, **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

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Course code	Course Name	L-T-P-Credits	Year of Introduction
ME471	Optimization Techniques	3-0-0-3	2016

Prerequisite - ME372 Operations Research

Course Objective:

- To learn the various optimization techniques for effective decision making.

Syllabus:

Linear programming – integer programming– network models – goal programming – dynamic programming – nonlinear programming – nontraditional optimization.

Expected Outcome:

- The students will be able to understand optimization techniques and apply them in solving practical problems

Text Books:

1. Miller, D. M. and Schmidt, J. W., Industrial Engineering and Operations Research, John Wiley & Sons, Singapore, 1990.
2. Paneerselvam, R., Operations Research, Prentice Hall of India, New Delhi, 2008.
3. Pannerselvam, R., Design and Analysis of Algorithms, Prentice Hall of India, New Delhi, 2007.
4. Taha, H. A., Operations Research, Pearson, 2004.

Reference Books:

1. Banks, J., Carson, J. S., Nelson, B. L., and Nicol, D. M., Discrete-Event System Simulation, Third Edition, Pearson Education, Inc., 2001
2. Goel, B. S. and Mittal, S. K., Operations Research, Pragati Prakashan, Meerut, 1999.
3. Ravindran, Phillips and Solberg, Operations Research Principles and Practice, Willey & Sons, 1987
5. Srinivasan, G. "Operations Research-Principles and Applications", latest edition, PHI Pvt. Ltd.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Review of linear programming– revised simplex method	1	15%
		1	
	Dual simplex method	1	

		1	
	Sensitivity analysis – changes affecting feasibility – changes affecting optimality	**1**	
		1	
		1	
II	Integer programming – importance – applications	**1**	**15%**
	Branch and bound technique	**1**	
		1	
	Gomory's cutting plane method	**1**	
		1	
	Solution to travelling salesman problem	**1**	
		1	
FIRST INTERNAL EXAMINATION			
III	Network models – minimal spanning tree problem	**1**	**15%**
	PRIM's algorithm	**1**	
	Kruskal's algorithm	**1**	
	Shortest route problem –applications	**1**	
	Systematic method	**1**	
	Dijkstra's algorithm	**1**	
	Floyd's algorithm	**1**	
IV	Goal programming – goal programming formulation-application.	**1**	**15%**
		1	
	Simplex method for solving goal programming	**1**	
		1	
	Dynamic programming – terminologies – forward and backward recursion –applications	**1**	
	Shortest path problems	**1**	
		1	
SECOND INTERNAL EXAMINATION			
V	Nonlinear programming – convex, quasi-convex, concave and unimodal functions – theory of constrained optimization	**1**	**20%**
		1	
		1	
	Lagrangean method	**1**	
		1	
	Kuhn-Tucker conditions	**1**	
		1	
VI	Nontraditional optimization – computational complexity- Introduction to metaheuristics – areas of application	**1**	**20%**
		1	
	Genetic algorithm (GA) – terminologies – steps and examples	**1**	
	Tabu search (TS) – steps and examples	**1**	
	Simulated annealing (SA) – steps and examples	**1**	
	Ant colony optimization (ACO) – steps and examples - Particle Swarm Optimization (PSO)-Steps and examples	**1**	
		1	

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

SYLLABUS

SEMESTER 8

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME 402	Design of Machine Elements-II	3-0-0-3	2016

Prerequisite: ME401 Design of Machine Elements-I

Course Objectives:

- To provide basic design methods for clutches, brakes, belt drives, bearings, gears and connecting rod.
- To introduce the design modifications to be considered for ease of manufacturing.

Syllabus

Design of single plate clutches, multiple disc clutches, cone clutch, centrifugal clutch, block brake, band brake, band and block brake, internal expanding shoe brake, rolling contact bearing, sliding contact bearing, spur gear, helical gear , bevel gear, worm and worm wheel, design of flat belt, design of V-belt drives, selection of roller chains, connecting road, design recommendations for forgings, castings, welded products, rolled sections, turned parts, screw machined products, parts produced on milling machines.

Expected outcome:

The students will be able to

1. Apply design procedures for industrial requirements.
2. Design machine components to ease the manufacturing limitations.

Text Books:

1. J. E. Shigley, Mechanical Engineering Design, McGraw Hill,2003
2. Jalaludeen , Machine Dsign, Anuradha Publications, 2016
3. V.B.Bhandari, Design of Machine elements, McGraw Hill, 2016

References Books:

1. Juvinall R.C & Marshek K.M., Fundamentals of Machine Component Design, John Wiley, 2011
2. M. F. Spotts, T. E. Shoup, Design of Machine Elements, Pearson Education, 2006
3. Rajendra Karwa, Machine Design , Laxmi Publications (P) LTD, New Delhi, 2006
4. Siegel, Maleev& Hartman, Mechanical Design of Machines, International Book Company, 1983

Data books permitted for reference in the examination:

1. K. Mahadevan, K.Balaveera Reddy, Design Data Hand Book, CBS Publishers & Distributors, 2013
2. Narayana Iyengar B.R & Lingaiah K, Machine Design Data Handbook, Tata McGraw Hill, 1984
3. PSG Design Data, DPV Printers, Coimbatore, 2012

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
I	Clutches – friction clutches, design considerations, multiple disc clutches, cone clutch, centrifugal clutch	2	15%
	Brakes- Block brake, band brake, band and block brake, internal expanding shoe brake	3	
II	Rolling contact bearing- Design of bearings, Types, Selection of a bearing type, bearing life, static and dynamic load capacity, axial and radial loads, selection of bearings, dynamic equivalent load	4	15%
	Sliding contact bearing- lubrication, lubricants, viscosity, Journal bearings, hydrodynamic theory, Sommerfield number, design considerations, heat balance, bearing housing and mountings	4	
FIRST INTERNAL EXAM			
III	Gears- classification, Gear nomenclature, Tooth profiles, Materials of gears, Law of gearing (review only), virtual or formative number of teeth, gear tooth failures, Beam strength, Lewis equation, Buckingham's equation for dynamic load, wear load, endurance strength of tooth, surface durability, heat dissipation – lubrication of gears – Merits and demerits of each type of gears.	3	15%
	Design of spur gear	3	
IV	Design of helical gear	2	15%
	Design of bevel gear	2	
	Design of worm & worm wheel	3	
SECOND INTERNAL EXAM			
V	Design of flat belt- materials for belts, slip of the belts, creep, centrifugal tension	3	20%
	Design of V-belt drives, Advantages and limitations of V-belt drive	3	
	Selection of roller chains, power rating of roller chains, galling of roller chains, polygonal action, silent chain.	3	
VI	Connecting rod – material, connecting rod shank, small end, big end, connecting rod bolts, inertia bending stress, piston	5	20%
	Pressure vessels, thin cylinders, Thick cylinder equation, open and closed cylinders.	2	
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Note : Use of approved data book is permitted

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 3 questions from module I and II and at least 1 question from each module
Each question carries 15 marks
Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part B
There should be 3 questions from module III and IV and at least 1 question from each module
Each question carries 15 marks
Students will have to answer any 2 questions out of 3 (2X15 marks =30 marks)

Part C
There should be 3 questions from module V and VI and at least 1 question from each module
Each question carries 20 marks
Students will have to answer any 2 questions out of 3 (2X20 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME404	INDUSTRIAL ENGINEERING	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To impart theoretical knowledge about various tools and techniques of Industrial Engineering.
- To create awareness about various safety procedures to be followed in carrying out different types of projects.
- To get acquainted with the Inventory management Principles and Techniques.
- To equip with the theoretical knowledge on Quality control practices and testing methods.

Syllabus

Introduction to Industrial Engineering, Plant layout and Material handling, Methods engineering, Industrial relations, Production planning and control, Quality control and Inspection

Expected outcomes:

The students will be able to

i. Know various tools and techniques in industrial Engineering.
ii. Develop work procedure applying the principles of work study.
iii. Apply inventory control techniques in materials management.
iv. Formulate replacement and purchase decisions and arrive at conclusions

Text Books:

1. B. Kumar, Industrial Engineering Khanna Publishers,2013
2. M Mahajan, Industrial Engineering & Production Management, Dhanpat Rai, 2005
3. Martand Telsang, Industrial Engineering & Production Management, S. Chand, 2006
4. O. P. Khanna, Industrial Engineering and Management, Dhanpat Rai, 2010

References:

1. E. S. Buffa, Modern Production management, John Wiley, 1983
2. Grant and Ieven Worth, Statistical Quality Control, McGraw Hill, 2000
3. Introduction to work study – ILO, Oxford And IBH Publishing,2008
4. Ralph M Barnes, Motion and Time Study, Wiley, 1980

Course

Module		Hours	End Sem. Exam Marks
I	Introduction to Industrial Engineering - Evolution of modern Concepts in Industrial Engineering - Functions of Industrial Engineering - Field of application of Industrial Engineering Product Development and research- Design function - Objectives of design, - Manufacturing vs purchase- Economic aspects- C-V-P analysis – simple problems-Development of designs- prototype, production and testing - Human factors in design- Value Engineering .	7	15%
II	Plant layout and Material handling- principles of material handling, Types of material handling equipments, Selection and application. Preventive and break- down maintenance - Replacement policy-- Methods of replacement analysis-Method of providing for depreciation- Determination of economic life - Simple problems.	7	15%

FIRST INTERNAL EXAM			
III	Methods engineering: Analysis of work methods using different types of process chart and flow diagrams- Critical examination- Micro motion study and therbligs- Principles of motion economy – Work measurement-Performance rating.-Determination of allowances and standard time. - Job evaluation and merit rating - Objectives and principles of job evaluation--Wages and Incentives- Primary wage systems- Wage incentive plans.	7	15%
IV	Industrial relations- Psychological attitudes to work and working conditions - fatigue- Methods of eliminating fatigue- Effect of Communication in Industry-Industrial safety-personal protective devices-, causes and effects of industrial disputes- Collective bargaining- Trade union - Workers participation in management.	7	15%
SECOND INTERNAL EXAM			
V	Production planning and control- Importance of planning - job, batch and mass production-Introduction and need for a new product- product life cycle. - Functions of production control - Routing , Scheduling, dispatching and follow up- Gantt charts. Inventory Control, Inventory models -Determination of EOQ and reorder level- simple problems- Selective inventory control techniques.	7	20%
VI	Quality control and Inspection- Destructive and non-destructive testing methods- process capability- Statistical quality control – causes of variation in quality- control charts for X and R. Reliability- causes of failures- Bath tub curve.-System reliability- life testing- Introduction to concepts of, TQM, ISO, Six Sigma and Quality circles (Brief description only).	7	20%
END SEMESTER EXAM			

Question paper pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II. Each question carries 10 marks. Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV. Each question carries 10 marks. Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI. Each question carries 10 marks. Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	Credits	Year of Introduction
**492	PROJECT	6	2016

Prerequisite : Nil

Course Objectives

- To apply engineering knowledge in practical problem solving
- To foster innovation in design of products, processes or systems
- To develop creative thinking in finding viable solutions to engineering problems

Course Plan

In depth study of the topic assigned in the light of the preliminary report prepared in the seventh semester
Review and finalization of the approach to the problem relating to the assigned topic
Preparing a detailed action plan for conducting the investigation, including team work
Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed
Final development of product/process, testing, results, conclusions and future directions
Preparing a paper for Conference presentation/Publication in Journals, if possible
Preparing a report in the standard format for being evaluated by the dept. assessment board
Final project presentation and viva voce by the assessment board including external expert

Expected outcome

The students will be able to

iii. Think innovatively on the development of components, products, processes or technologies in the engineering field
iv. Apply knowledge gained in solving real life engineering problems

Evaluation

Maximum Marks : 100

(i) Two progress assessments	20% by the faculty supervisor(s)
(ii) Final project report	30% by the assessment board
(iii) Project presentation and viva voce	50% by the assessment board

Note: All the three evaluations are mandatory for course completion and for awarding the final grade.

SYLLABUS

Elective 4

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME462	Propulsion Engineering	3-0-0-3	2016

Prerequisite: Nil

Course Objectives:

- To give an overview of various air craft engines, rocket engines and their applications.
- To provide knowhow on tools to analyze various rocket propulsion.
- To know the testing of rocket engines .

Syllabus:

Fundamentals of Propulsion, Types of propulsive devices, Efficiencies, Thermodynamics analysis of turbojet, Turbojet engine components, Rocket propulsion, Types of rockets, Flight Performance, Testing of rockets

Expected Outcomes:

The students will be able to

i. Perform thermodynamic analysis of aircraft engines
ii. Carry out performance analysis of aircraft systems and components
iii. Formulate and solve rocket engine problems

Text books:

1. K Ramamurthi, Rocket Propulsion, Laxmi Publications, 2016
2. Saeed Farokhi, Aircraft Propulsion, Wiley, 2e, 2014

Reference books:

1. G. P. Sutton and Oscar Biblarz, Rocket Propulsion elements- John Wiley & Sons, 2013
2. J Mattingly, H von Ohain, Elements of Propulsion: Gas Turbines and Rockets, AIAA, 2006
3. Philip Hill, Carl Peterson: Mechanics and Thermodynamics of Propulsion, Pearson, 2014
4. Ronald D Flack, Fundamentals of Jet Propulsion with Applications, Cambridge University Press, 2005

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Fundamentals of Propulsion- Classification types of propulsive devices-Airscrew, Turbojet, Turboprop, turbofan, Turboshaft, Ramjet, Scramjet, Pulsejet and Rocket engines. Comparative study of performance characteristics applications.	7	15%
II	Theory of propulsion – Thrust, thrust power and efficiencies of turbojet engine. Thermodynamics analysis of turbojet engine cycle, Propellers: Types of propellers	7	15%
FIRST INTERNAL EXAMINATION			

III	Turbojet engine components- air intakes, Compressors, Combustion chambers, turbines, nozzles turbine and compression matching – Thrust augmentation.	**7**	**15%**
IV	Rocket propulsion- general operating principles of chemical, electrical nuclear and solar rockets. Chemical Rockets- Classification. Performance parameters for chemical rockets and their relationship, Energy and efficiencies, simple problems, Solid propellants- Types- burning rate- grain Configurations, - Classification- Typical fuels and oxidizers, properties and specifications, Selection.	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Liquid propellant feed systems, injectors, Starting and ignition, Igniters liquid propellant, Precautions in propellant handling. Hybrid Rockets combustion processes in SPR and LPR combustion instability- Control of instabilities –Cooling of Rocket motors	**7**	**20%**
V1	Flight Performance- Velocity and attitude in simplified vertical Refractory staging of rockets. Rocket Testing- Test facilities and safeguards. Measurement System Terminology, Flight Testing.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

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Estd.
2014

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME464	Robotics and Automation	3-0-0-3	2016

Prerequisite : Nil

Course Objectives: :

- To provide the concepts of vision system and image processing
- To equip students to write programs for automatic functioning of a robot
- To familiarise various robot sensors and their perception principles that enable a robot

Syllabus:

Definition ,Co-ordinate Systems, Work Envelope, types and classification, Robot drive systems, End Effectors, Grippers, Sensors and machine vision, Robot kinematics and robot programming, Application of robots in machining.

Expected Outcomes:

The students will be able to

i. Become familiar with the history, concept, development and key components of robotics technologies
ii. Classify and characterize the robots based on the configuration and work volume
iii. Solve the problems related to robot design and control

Text books:

1. Industrial Robots, Yu.Kozyrev, Mir Publishers
2. Janakiraman.P.A., Robotics and Image Processing, Tata McGraw-Hill, 1995
3. M.P.Groover, Industrial Robotics – Technology, Programming and Applications, McGraw-Hill, 2001
4. Yoram Koren, Robotics for Engineers, McGraw-Hill Book Co., 1992

References:

1. Fu.K.S. Gonzalz.R.C., and Lee C.S.G., Robotics Control, Sensing, Vision and Intelligence, McGraw-Hill Book Co., 1987
2. K.S.Fu., R.C.Gonalez, C.S.G.Lee, Robotics Control sensing, Vision andIntelligence, McGraw Hill International Edition, 1987
3. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, Robotic engineering-An Integrated Approach , Prentice Hall Inc, 1989

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Definition – Co-ordinate Systems, Work Envelope, types and classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Basic robot motions - Point to point control, Continuous path control. Robot Parts and Their Functions – Need for Robots Different Applications.	7	15%
II	Robot drive systems: Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C. Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications	7	15%

	and Comparison of all these Drives.		
FIRST INTERNAL EXAMINATION			
III	End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations	**7**	**15%**
IV	Sensors and machine vision: Requirements of a sensor, Principles and Applications of the following types of sensors – Position of sensors (Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders), Range Sensors (Triangulation Principle, Structured, Lighting Approach, Laser Range Meters).	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Proximity Sensors(Inductive, Capacitive, and Ultrasonic), Touch Sensors, (Binary Sensors, Analog Sensors), Wrist Sensors, Compliance Sensors, Slip Sensors. Camera, Frame Grabber, Sensing and Digitizing Image Data – Signal Conversion, Image Storage, Lighting Techniques. Robot kinematics and robot programming: Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two Degrees of Freedom (In 2 Dimensional) – Deviations and Problems.	**7**	**20%**
V1	Teach Pendant Programming, Lead through programming, Robot programming Languages –VAL Programming – Motion Commands, Sensor Commands, End effecter commands, and Simple programs. Industrial Applications: Application of robots in machining, welding, assembly, and material handling.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum **marks: 100** **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: in all parts each question can have a maximum of four sub questions

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME466	Computational Fluid Dynamics	3-0-0-3	2016

Prerequisite : ME203 Mechanics of fluids

Course Objectives: :

- To introduce governing equations of viscous fluid flows
- To introduce numerical modelling and its role in the field of fluid flow and heat transfer
- To enable the students to understand the various discretization methods, solution procedures and turbulence modelling.
- To create confidence to solve complex problems in the field of fluid flow and heat transfer using high speed computers.

Syllabus:

Introduction to CFD, Governing equations, Steady and unsteady flows, Analytical solution of a one dimensional convection diffusion equation, Statistical representation of turbulent flows, Different types of turbulence models, Grid generation, Pressure-velocity decoupling for incompressible flows, Typical results of CFD analysis

Expected Outcomes:

The students will be able to

i. Grasp numerical modelling and its role in the field of fluid flow and heat transfer
ii. Apply the various discretization methods, solution procedures and turbulence modeling to solve flow and heat transfer problems
iii. Know established engineering methods to solve complex engineering problem

Text books:

1. Patankar Suhas V., Numerical Heat Transfer and Fluid Flow, Taylor &Francis,1980
2. Versteeg H.K. &Malalasekera W., An introduction to Computational Fluid Dynamics, Longman,2008

Reference books:

1. Anderson Dale A., Tannehill John C. &Pletcher Richard H., Computational Fluid Mechanics and Heat Transfer, Taylor & Francis, 2016
2. Fletcher C.A.J., Computational Techniques for Fluid Dynamics I, Springer Verlag,1984

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to CFD, Historical background, applications, advantages. Basic steps of CFD. Meshes, Structured and unstructured mesh, Classification of structured grids. Governing equations: continuity and momentum equations. Equation of transport of a scalar. Potential, Euler and Navier-Stokes equations	7	15%
II	Steady and unsteady flows. Typical boundary conditions such as Dirichlets and Neumann conditions. TDMA method., Numerical	7	15%

	problem up to four unknowns using TDMA. Cell centred finite volume discretisation of terms of governing equations such as time derivative, convective and diffusion.		
FIRST INTERNAL EXAMINATION			
III	Analytical solution of a one dimensional convection diffusion equation. Upwind, central and blended difference approximations for convection term, QUICK scheme. Implicit, explicit and Crank-Nicolson schemes	**7**	**15%**
IV	Statistical representation of turbulent flows: Homogeneous turbulence and isotropic turbulence, General Properties of turbulent quantities, Reynolds average Navier stokes (RANS) equation, Closure problem in turbulence	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Turbulence modeling, Different types of turbulence models: advantages and disadvantages. Structured Grid generation – Unstructured Grid generation– Mesh refinement – Adaptive mesh	**7**	**20%**
VI	Pressure-velocity decoupling for incompressible flows - SIMPLE and PISO algorithms. Density based solutions for compressible flow, TVD and Van-leerschemes for compressible flow. Typical results of CFD analysis. Stream lines, method for generating stream line, velocity contours and pressure contours, Method of drawing a velocity vector. Solution of Lagrangian coordinates of a fluid particle. Commercial CFD packages.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME468	Nanotechnology	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To introduce nanotechnology and nanostructures
- To introduce fabrication and characterization techniques used in nanotechnology

Syllabus:

Introduction and scope, nanostructures Effect of Nanoscale dimensions on various properties, Fabrication methods, Characterisation methods, Applications of Nanotechnology (nano materials and devices), Nanomachines, Nanofluids, Nanoswitches, nano computers, nanofilters

Expected Outcomes:

The students will be able to

i. Understand properties of materials at nanoscale
ii. Know the fabrication and characterization methods used in nanotechnology
iii. Acquaint with the various applications of nanotechnology

Text books:

1. A.K. Bandyopdhyay, Nanomaterials, , New age international publishers,2008
2. Bharat Bhushan, Springer Handbook of Nanotechnology, 2010
   Charles P Poole, Frank J Owens, Introduction to Nanotechnology, John Wiley and Sons, 2003
3. Jeremy Ramsden,Nanotechnology, William Andrew, Elsevier, 2011
4. T Pradeep, Nano: The essentials, McGraw – Hill education,2 007
5. V.S.Muralidharan, A Subramnya,Nano science and Technology, Ane books Pvt Ltd

Reference books:

1. Gregory Timp, Nanotechnology, Springer-Verlag, 2009
2. John Mongillo, Nano Technology, Greenwood Press, 2007
3. Kelsall Robert. W, Ian Hamley, MarkGeoghegan, Nanoscale Science and Technology, Wiley Eastern,2005

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction and scope-Classification of nanostructures: Quantum dots, quantum wires, quantum wells, nanoclusters, nanotubes, super lattices, nanocrystalline materials-Effects of nanometer length scale – Changes to the system total energy, changes to the system structures.	7	15%
II	Effect of Nanoscale dimensions on various properties – structural, thermal, chemical, mechanical, magnetic, optical and electronic properties.	7	15%
FIRST INTERNAL EXAMINATION			

III	Fabrication methods: Top down and bottom up approaches-Top down processes: Milling, Lithographics, machining process, pulsed laser methods- Bottom up processes: Vapour phase deposition methods, PVD, CVD, electro deposition, plasma assisted deposition process, MBE, chemical methods, colloidal and solgel methods	**7**	**15%**
IV	Characterisation methods: General classification of characterization methods, Microscopy techniques: Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy, Diffraction Techniques-Spectroscopy Techniques – Raman Spectroscopy, Surface analysis and depth profiling- Mechanical Properties-Magnetic and Thermal properties.	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Applications of Nanotechnology (nano materials and devices)-Applications of nanocomposites, nanocrystalline materials, nano layered structures, nanomagnetic materials-magneto resistance-Carbon nanotubes: SW, MW, nanostructured coatings- nano sensors: order from chaos, characterization, perception, nano sensor based on quantum size effect, Electrochemical sensors, Sensors based on physical properties, Nanobiosensors, smart dust	**7**	**20%**
V1	Nanomachines: covalent and non covalent approaches, Molecular motors and machines, molecular devices, single molecular devices, practical problems with molecular device- Nanofluids: nanoparticles, preparation of nanofluids, thermophysical properties of nanofluids in comparison with base fluid. Nanoswitches - nano computers- nanofilters	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)
Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME472	FAILURE ANALYSIS AND DESIGN	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

1. To understand the failure modes and theories of failure.
2. To include the effect of cyclic loading, fatigue and endurance limit in design.
3. To understand the methods for lifecycle prediction.

Syllabus

Material failure modes and their identification. Static loading, combined stress, theories of failure. Fatigue loading, high cycle fatigue, fatigue testing, S-N-P curves, endurance diagrams, influence factors, stress concentration factors and notch sensitivity, fatigue design for combined stress, cumulative damage and life prediction, low cycle fatigue, fracture mechanics principles in design practice, contact fatigue, high temperatures, corrosion. Shock and impact loading.

Expected outcome

The students will be able to

i. analyze real life failure modes and use of theories for failure prediction
ii. design for fatigue and cyclic loading
iii. make comprehensive life cycle prediction of designed products

Text Books:

1. Collins. J. A., Failure of Materials in Mechanical Design, John Wiley & Sons, 1993
2. Suresh S, Fatigue of Materials, Cambridge University Press, 1998

References Books:

1. Prashant Kumar, Elements of Fracture Mechanics, Wheeler Publishing, 1999
2. Withered C. E., Mechanical Failure Avoidance Strategies and Techniques, McGraw-Hill, 1994

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to material failure modes- Identification of failure modes	3	15%
	Combined stresses –Theories of failure	5	

II	Fatigue loading, high cycle fatigue, fatigue testing, S-N-P curves-factors affecting S-N-P curve- endurance diagrams	6	20%
FIRST INTERNAL EXAM			
III	Cumulative damage and life prediction- Fracture control	5	15%
	Fatigue design for combined stress	2	
IV	Low cycle fatigue – Cumulative damage in low cycle fatigue	4	20%
	Influence factors- Stress concentration factors and notch sensitivity	4	
SECOND INTERNAL EXAM			
V	Fracture mechanics principles in design practice	6	15%
VI	Contact fatigue, high temperatures, corrosion	4	15%
	Shock and impact loading.	3	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME474	Micro and Nano Manufacturing	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

1. To give awareness of different techniques used in micro and nano manufacturing
2. To give in-depth idea of the conventional techniques used in micro manufacturing
3. To introduce Non-conventional micro-nano manufacturing and finishing approaches
4. To introduce Micro and Nanofabrication Techniques and other processing routes in Micro and nano manufacturing
5. To know different techniques used in Micro Joining and the metrology tools in micro and nano manufacturing.

Syllabus

Introduction to Precision engineering- Bulk micromachining – Micro-energy -Carbon Nanotubes - Molecular Logic Gates and Nanolevel Biosensors - Conventional Micro Machining - Non-conventional micro-nano manufacturing and finishing approaches - Micro and Nano Finishing Processes - Micro and Nanofabrication Techniques - Micro Joining - Characterization and metrology tools.

Expected outcome

The students will

1. get an awareness of different techniques used in micro and nano manufacturing.
2. get in-depth idea of the conventional techniques used in micro manufacturing.
3. become aware about non-conventional micro-nano manufacturing and finishing approaches.
4. get awareness on micro and nano finishing processes.
5. understand micro and nanofabrication techniques and other processing routes in micro and nano manufacturing.
6. know about different techniques used in micro joining and the metrology tools in micro and nano manufacturing.

References:

1. Mark. J. Jackson, Micro and Nano-manufacturing, Springer, 2006.
2. Mark. J. Jackson, Micro-fabrication and Nano-manufacturing - Pulsed water drop micromachining CRC Press 2006.
3. Nitaigour Premchand Mahalik, Micro-manufacturing and Nanotechnology, 2006.
4. V.K.Jain, Micro-manufacturing Processes, CRC Press, 2012.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Introduction to Precision engineering, macro milling and micro drilling, Micro-electromechanical systems – merits and applications, Micro phenomenon in Electro-photography – applications	1	15%

	Introduction to Bulk micromachining, Surface micromachining-steps, Micro instrumentation – applications, Micro Mechatronics, Nanofinishing – finishing operations.	**1**	
	Laser technology in micro manufacturing- Practical Lasers, application of technology fundamentals	**1**	
	Introduction to Micro-energy and chemical system (MECS), Space Micro-propulsion, e-Beam Nanolithography – important techniques, Introduction to Nanotechnology	**1**	
	Carbon Nano-tubes – properties and structures, Molecular Logic Gates and Nano level Biosensors - applications	**1**	
II	Introduction to mechanical micromachining, Micro drilling – process, tools and applications	**1**	**15%**
	Micro turning- process, tools and applications, Diamond Micro turning – process, tools and applications	**1**	
	Micro milling and Micro grinding – process, tools and applications	**1**	
	Micro extrusion- process and applications	**1**	
	micro bending with Laser	**1**	
	Nano- Plastic forming and Roller Imprinting	**1**	
	FIRST INTERNAL EXAMINATION		
III	Introduction to Non-conventional micro-nano manufacturing	**1**	**15%**
	Process, principle and applications – Abrasive Jet Micro Machining, WAJMM	**1**	
	Micro EDM, Micro WEDM, Micro EBM – Process principle, description and applications	**1**	
	Micro ECM, Micro LBM - Process principle, description and applications	**1**	
	Focused ion beams - Principle and applications	**1**	
IV	Introduction to Micro and Nano Finishing Processes	**1**	**15%**
	Magnetorheological Finishing (MRF) processes, Magnetorheological abrasive flow finishing processes (MRAFF) – process principle and applications	**1**	
	Force analysis of MRAFF process,	**1**	
	Magnetorheological Jet finishing processes	**1**	
	Working principle and polishing performance of MR Jet Machine	**1**	
	Elastic Emission Machining (EEM) – machine description, applications	**1**	
	Ion Beam Machining (IBM) – principle, mechanism of material removal, applications	**1**	
	Chemical Mechanical Polishing (CMP) – Schematic diagram, principle and applications	**1**	
	SECOND INTERNAL EXAMINATION		
V	Introduction to Micro Fabrication: basics, flowchart, basic chip	**1**	**20%**

	making processes		
	Introduction to Nanofabrication, Nanofabrication using soft lithography – principle, applications – Examples (Field Effect Transistor, Elastic Stamp)	**1**	
	Manipulative techniques – process principle, applications	**1**	
	Introduction to Carbon nano materials – CN Tubes	**1**	
	CN Tubes – properties and applications	**1**	
	CN Tube Transistors – Description only	**1**	
	Diamond - Properties and applications	**1**	
	CVD Diamond Technology	**1**	
	LIGA Process	**1**	
V1	Laser Micro welding – description and applications, Defects	**1**	**20%**
	Electron Beam Micro-welding – description and applications	**1**	
	Introduction to micro and nano measurement, defining the scale, uncertainty	**1**	
	Scanning Electron Microscopy – description, principle	**1**	
	Scanning White-light Interferometry – Principle and application	**1**	
	Optical Microscopy – description, application	**1**	
	Scanning Probe Microscopy, scanning tunneling microscopy- description, application	**1**	
	Confocal Microscopy - description, application	**1**	
	Introduction to On-Machine Metrology	**1**	
	END SEMESTER EXAMINATION		

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME476	Material Handling & Facilities Planning	3-0-0-3	2016

Prerequisite : Nil

Course Objectives: :

- To understand the overall facilities planning process
- To educate product, process and schedule design and their effects on the facility layout
- To introduce concepts of material handling and safety in industries.

Syllabus:

Design of layout of factories, General equipment for amenities of working people, Computer applications in layout designs, Environmental aspects, Plant safety, Economical aspects

Expected Outcomes:

The students will be able to

i. Assess the value of facility planning on the strategy of a firm
ii. Develop a systematic plant layout
iii. Know the environmental and economical aspects in facilities planning
iv. Understand various material handling systems

Text books/Reference books:

1. A W Peymberton, Plant layout and Material Handling, John Wiley
2. James A Apple, Plant layout and Material Handlin, Krieger Pub Co,1998
3. John A Sehbin, Plant layout and Material Handling-
4. K C Arora & Shinde, Aspects of Material handling, Lakshmi Publications.
5. P B Mahapatra, Operations Management, PHI, 2010

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Design of layout of factories, Office, Storage area etc. on consideration of facilities of working people, Storage facilities and general equipment for amenities of working people – Product, Process and combination layout –Systematic layout planning, Design of Assembly lines, Line balancing methods.	8	15%
II	Computer applications in layout designs, Environmental aspects like lighting, Ventilation, dust control, humidity. Different type of Plant services like steam compressed air etc.	6	15%
	FIRST INTERNAL EXAMINATION		
III	Plant safety, Elements off Industrial safety- Causes and prevention of accidents – Pollution and environmental consideration.	6	15%
IV	Introduction, Material Handling systems, Material Handling principles, Classification of Material Handling Equipment, Relationship of material handling to plant layout.	8	15%

SECOND INTERNAL EXAMINATION			
V	Basic Material Handling systems: Selection, Material Handling method- path, Equipment, function oriented systems.	**7**	**20%**
V1	Methods to minimize cost of material handling- Maintenance of Material Handling Equipments, Safety in handling, Ergonomics of Material Handling equipment. Design, Miscellaneous equipment	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

SYLLABUS

Non Departmental Electives

Course code	Course name	L-T-P-Credits	Year Of Introduction
AE482	INDUSTRIAL INSTRUMENTATION	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To equip the students with the basic knowledge of pressure, temperature, flow, level, density and viscosity measurements.
- To understand the construction and working of measuring instruments

Syllabus

Temperature measurement- Pressure measurement- Measurement of viscosity- Flow measurement- Anemometers- Target flow meters- Level measurement

Expected outcome

- The student will be able to understand the various instruments used for industrial measurement.

Text Books

1. Doebelin E.O, "*Measurement Systems: Application and Design*", 4th Edition, McGraw Hill, New York, 2003.
2. Patranabis D, "*Principles of Industrial Instrumentation*", 2ndEdition, Tata McGraw Hill, New Delhi, 1997.
3. Spitzer D. W., *Flow measurement*, ISA press, New York, 1998

Reference Books

1. Andrew W.G, "*Applied Instrumentation in Process Industries – A survey*", Vol I & Vol II, Gulf Publishing Company, Houston, 2001.
2. Douglas M. Considine, "*Process / Industrial Instruments & Controls Handbook*", 5th Edition, McGraw Hill, Singapore, 1999.
3. Liptak B.G, "*Process Measurement and Analysis*", 4th Edition, Chilton Book Company, Radnor, Pennsylvania, 2003.
4. Noltingk B.E., *"Instrumentation Reference Book"*, 2ndEdition, Butterworth Heinemann, 1995.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Temperature measurement: Resistance temperature detector (RTD), principle and types, construction requirements for industry, measuring circuits. Thermistors, principle and sensor types, manufacturing techniques, measuring circuits, linearization methods and applications. Pneumatic and suction pyrometers, integrated circuit sensors, diode type sensors, ultrasonic thermometers, Johnson noise thermometer, fluidic sensors, spectroscopic temperature measurements, thermograph, temperature switches and thermostats.	7	15%
II	Pressure measurement basics, mechanical type instruments, electromechanical type, low pressure measurement, related accessories, pressure measuring standards, selection and application. Transmitter definition, classification, pneumatic transmitter-force balance type, torque balance type, two wire and four wire transmitters, I/P and P/I converters.	7	15%

FIRST INTERNAL EXAMINATION			
III	Measurement of viscosity: definitions, units, Newtonian and Newtonian behaviour, measurement of viscosity using laboratory viscometers, industrial viscometers. Viscometer selection and application. Measurement of density, definitions, units, liquid density measurement, gas densitometers, its application and selection.	7	15%
IV	Flow measurement: Introduction, definitions and units, classification of flow meters, pitot tubes, positive displacement liquid meters and provers, positive displacement gas flow meters, variable area flow meters.	6	15%
SECOND INTERNAL EXAMINATION			
V	Anemometers: Hot wire/hot film anemometer, laser Doppler anemometer (LDA), electromagnetic flow meter, turbine and other rotary element flow meters, ultrasonic flow meters, doppler flow meters, cross correlation flow meters, vortex flow meters. Measurement of mass flow rate: radiation, angular momentum, impeller, turbine, constant torque hysteresis clutch, twin turbine Coriolis, gyroscopic and heat transfer type mass flow meters. Target flow meters: V-cone flow meters purge flow regulators, flow switches, flow meter calibration concepts, flow meter selection and application.	8	20%
VI	Level measurement: introduction, float level devices, displacer level devices, rotating paddle switches, diaphragm and deferential pressure detectors, resistance, capacitance and RF probes, radiation, conductivity, field effect, thermal, ultrasonic, microwave level switches, radar and vibrating type level sensors. Level sensor selection and application.	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

Part A
Answer any two out of three questions from Module 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions. (15 x 2 = 30 marks)

Part B
Answer any two out of three questions from Module 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions. (15 x 2 = 30 marks)

Part C
Answer any two out of three questions from Module 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions. (20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE484	INSTRUMENTATION SYSTEM DESIGN	3-0-0-3	2016

Prerequisite : NIL

Course Objective

- To equip the students with the basic Concept of Instrumentation system design
- To understand the construction and working of different instrumentation system

Syllabus

Temperature measurement- Pressure measurement- Measurement of viscosity- Flow measurement- Anemometers- Target flow meters- Level measurement

Expected outcome

The students will be able to understand the concepts behind instrumentation system design and its working

Text Books

1. E.O. Dobelin, Measurement Systems Application and Design, McGraw Hill, New York, 2003
2. Harry N Norton, Hand Book of transducers, PHI, 1989

Reference Books

1. Gregory K McMillan, Douglas M Conside, Process and Industrial Instrumentation Control, McGraw Hill, 5ed, 1999
2. John P Bentley, Principles of Measurement Systems, Pearson Education, 2004

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction: Concept of generalized measurement system, functional elements, generalized input-output configuration, static sensitivity, drifts, linearity, hysteresis, threshold, resolution, static stiffness and input-output impedance	7	15%
II	Transducers: Operating principle, construction and design of variable resistive transducers, variable inductive transducers, variable capacitive transducers, piezoelectric transducers, magnetostrictive transducers	7	15%
	FIRST INTERNAL EXAMINATION		
III	Hall effect, eddy current, ionization, optical transducers, digital transducers, single shaft encoders, photo voltaic cell, photo conductive, photo emissive, fiber optic sensors, concept of smart and intelligent sensor, bio-sensors	7	15%
IV	Construction and performance of industrially important transducer for measuring displacement, speed, vibrations, temperature, electrical power, strain, torque Force, Design of intelligent instrumentation system.	6	15%
	SECOND INTERNAL EXAMINATION		
V	Signal Conditioning & Recording (Part1): Quarter, half and full bridge circuit, active filters, differential instrumentation amplifiers, carrier amplifiers	8	20%
VI	Signal Conditioning & Recording (Part2): design of display elements, LED, bar graph displays, LCDs , nixie tube and their interfacing	7	20%

END SEMESTER EXAMINATION

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

Part A
Answer any two out of three questions from Module 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions. (15 x 2 = 30 marks)

Part B
Answer any two out of three questions from Module 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions. (15 x 2 = 30 marks)

Part C
Answer any two out of three questions from Module 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions. (20 x 2 = 40 marks)

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
KTU
Estd.
2014

Course code	Course Name	L-T-P - Credits	Year of Introduction
AO482	FLIGHT AGAINST GRAVITY	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To introduce the basic concepts of aerospace engineering and the current developments in the field.

Syllabus:

History of aeronautics – helicopters – aircraft propulsion – aircraft configurations – Atmosphere and atmospheric flight – space flight – aircraft structures and materials – rockets.

Text Book:

Anderson, J.D., "Introduction to Flight", McGraw-Hill, 1995.

Reference:

Kermode, A.C., "Flight without Formulae", McGraw-Hill, 1997.

Syllabus &Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Historical Developments in Aeronautical Activities: Early air vehicles: Balloons, Biplanes and Monoplanes	3	15%
	Helicopters; Developments in aerodynamics, aircraft materials, aircraft structures & aircraft propulsion.	3	
II	Aircraft Configurations: Different types of flight vehicles and their classifications;	2	
	Components of fixed wing airplane and their functions;	2	
	Airfoils, wings and other shapes.	2	15%
	FIRST INTERNAL EXAMINATION		
III	Principles of Atmospheric Flight: Physical properties and structure of the atmosphere:	3	15%
	The Standard Atmosphere, Temperature, Pressure and Altitude relationships, Mach number	2	
	Evolution of theory of lift and drag, Maneuvers, Concepts of stability and control.	3	
IV	Introduction to Space Flight: Introduction to basic concepts, the upper atmosphere	3	15%
	Space vehicle trajectories-some basic concepts, Kepler's Laws of planetary motion.	3	
	SECOND INTERNAL EXAMINATION		
V	Introduction to airplane structures and materials : General types of construction, Monocoque, semi-monocoque.	3	20%
	Typical wing and fuselage structure. Metallic and non-metallic materials	2	
	Use of aluminium alloy, titanium, stainless steel and composite materials.	2	
VI	Power plants used in airplanes : Basic ideas about piston, turboprop and jet engines.	3	20%

	Comparative merits, Principles of operation of rocket, types of rockets and typical applications,	3	
	Exploration into space.	2	
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 Exam duration: 3 hours

The question paper shall consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

Course code.	Course Name	L-T-P -C	Year of Introduction
AU484	MICROPROCESSOR AND EMBEDDED SYSTEMS	3-0-0-3	2016

Prerequisite: NIL

Course Objectives

- To impart the basic concepts of microprocessors
- To impart the basic concepts of embedded systems

Syllabus

Introduction to microprocessors, Intel 8085 microprocessor, Instruction Set of 8085, Assembly language programming, Interfacing I/O devices, Overview of embedded system, Intel 8051 microcontroller, 8051 interfacing, Other microcontroller architectures: PIC-Atmel AVR-ARM

Expected outcome.

The students will

i. Get idea about Intel 8085 Microprocessor
ii. Be able to do assembly language programming
iii. Gain an overview of embedded systems
iv. Know about Intel 8051 microcontroller and its interfacing

Text Books:

1. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Fifth edition, Prentice hall, 2002.
2. Shibu K.V, Introduction to Embedded Systems, Tata McGraw Hill, 2009

References:

1. Aditya P. Mathur, "Introduction to Microprocessors", Third Edition, Tata McGraw-Hill Publishing Co Ltd., New Delhi, 1989.
2. Ahson.S.I., "Microprocessors with Applications in Process Control", Tata McGraw-Hill Publishing Co Ltd.,New Delhi, 1986.
3. K Uma Rao,"The 8051 Microcontrollers: Architecture, Programming & Applications", Pearson, 2010.
4. Steve Heath, "Embedded system design second edition", Elsevier, 2002

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	**Introduction to microprocessors:** Microcomputers and microprocessors, 8/16/32/ 64-bit microprocessor families. Internal architecture of Intel 8085 microprocessor: Block diagrams, Registers, Functional details of pins, Control signals.	7	15%
II	**Instruction Set of 8085:** Instruction set, Instruction format, Addressing modes. Machine cycle and instruction cycles, Timing diagrams, Fetch and execute operations. **Assembly Language Programming:** Data copy operations, Arithmetic operations, Branching operations, Logic and bit manipulation instructions	7	15%
FIRST INTERNAL EXAMINATION			
III	**Interfacing I/O devices:** Interrupts, Programmable interface	7	15%

	devices,Interfacing keyboard and seven segment display, Serial I/O and data communication.		
IV	**Overview of Embedded System:**Embedded System, Categories of Embedded System, Requirements of Embedded Systems, Challenges and Issues in Embedded Software Development, Major application areas of embedded system.	7	15%
SECOND INTERNAL EXAMINATION			
V	**Intel 8051 microcontroller:** Architecture, Memory organization, Registers and I/O ports, Addressing modes, Instruction sets, Assembly language programming.	7	20%
VI	**8051 interfacing:**Keyboard, Stepper motor, ADC, DAC, and LCD module interface. Frequency counter and temperature measurement. **Other microcontroller architectures:** Microchip technology PIC, Atmel AVR, ARM core processors.	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 Duration: 3 hrs

The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI.Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a **maximum** of four sub questions, if needed.

Course code	Course Name	L-T-P - C	Year of Introduction
AU486	Noise, Vibration and Harshness	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- To impart the basics of noise, vibration, sources of vibration and noise in automobiles
- To study the effect of noise and vibration on human beings and nature.
- To introduce the methods of measurement of noise and vibration.
- To provide knowhow on various methods to reduce the vibration and noise

Syllabus

Fundamentals of Acoustics and Noise, Vibration - Effects of Noise, Blast, Vibration, and Shock on People- Introduction to Transportation Noise and Vibration Sources – Engine noise - Reduction of noise and vibrations - Noise and Vibration Transducers - Noise and Vibration Measurements - Vibration Data Analysis

Expected outcome.

The students will

i. understand the sources, effects, prediction, control techniques, measurement techniques of noise, vibration pertain to an automobile

ii. know about reduction of noise and vibration from an automobile.

Text Books:

1. Clarence W. de Silva , "Vibration Monitoring, Testing, and Instrumentation ",CRC Press, 2007
2. Colin H Hansen "Understanding Active Noise Cancellation" , Spon Press , London 2003
3. Kewal Pujara "Vibrations and Noise for Engineers, Dhanpat Rai & Sons, 1992.
4. Singiresu S.Rao,"Mechanical Vibrations" - Pearson Education, ISBM –81-297-0179-2004.

References:

1. Allan G. Piersol ,Thomas L. Paez "Harris' Shock and Vibration Handbook" , McGraw-Hill , New Delhi, 2010
2. Bernard Challen and Rodica Baranescu - "Diesel Engine Refrence Book" - Second edition - SAE International - ISBN 0-7680-0403-9 – 1999.
3. David A.Bies and Colin H.Hansen "Engineering Noise Control: Theory and Practice "Spon Press, London, 2009
4. Julian Happian-Smith - "An Introduction to Modern Vehicle Design"- Butterworth-Heinemann, ISBN 0750-5044-3 – 2004
5. Matthew Harrison "Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles ", Elsevier Butterworth-Heinemann, Burlington, 2004

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Fundamentals of Acoustics and Noise, Vibration: Introduction, classification of vibration and noises: Theory of Sound—Predictions and Measurement, Sound Sources, Sound Propagation in the Atmosphere, Sound Radiation from Structures and Their Response to	7	15%

	Sound, General Introduction to Vibration, free and forced vibration, undamped and damped vibration, linear and non linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems		
II	Effects of Noise, Blast, Vibration, and Shock on People: General Introduction to Noise and Vibration Effects on People and Hearing Conservation, Noise Exposure, Noise-Induced Annoyance, Effects of Infrasound, Low-Frequency Noise, and Ultrasound on People, Effects of Intense Noise on People and Hearing Loss, Effects of Vibration on People, Effects of Mechanical Shock on People, Rating Measures, Descriptors, Criteria, and Procedures for Determining Human Response to Noise.	7	15%
FIRST INTERNAL EXAMINATION			
III	Introduction to Transportation Noise and Vibration Sources, Noise Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine accessory contributed noise, transmission noise, aerodynamic noise, tyre noise, brake noise	7	15%
IV	Reduction of noise and vibrations I: Vibration isolation, tuned absorbers, untuned viscous dampers, damping treatments, application dynamic forces generated by IC engines, engine isolation, crank shaft damping, modal analysis of the mass elastic model shock absorbers.	7	15%
SECOND INTERNAL EXAMINATION			
V	Reduction of noise and vibrations: noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis. Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers	8	20%
VI	Noise and Vibration Transducers, Analysis Equipment, Signal Processing, and Measuring Techniques: General Introduction to Noise and Vibration Transducers, Measuring Equipment, Measurements, Signal Acquisition and Processing, Acoustical Transducer Principles and Types of Microphones, Vibration Transducer Principles and Types of Vibration Transducers, Sound Level Meters, Noise Dosimeters, Analyzers and Signal Generators, Equipment for Data Acquisition, Noise and Vibration Measurements, Determination of Sound Power Level and Emission Sound Pressure Level, Sound Intensity Measurements, Noise and Vibration Data Analysis, Calibration of Measurement Microphones, Calibration of Shock and Vibration Transducers.	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 Duration: 3 hrs

The question paper should consist of three parts

Part A
4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
6 questions uniformly covering modules V and VI.Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a **maximum** of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
BM482	BIOMEDICAL INSTRUMENTATION	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To impart knowledge about the principle and working of different types of biomedical electronic equipment/ devices.

Syllabus

Bioelectric potentials, Electrodes, Transducers, ECG, Pacemakers, Defibrillators, PCG, Blood pressure, PPG, Pulse oximeters, Holter ECG, Stress testing, Patient monitoring systems, EEG, EP, EMG, Spirometers, Heart lung machine, Infant incubators, Infusion pumps, Artificial heart valves, lithotripsy, Surgical diathermy, X-ray radiography, CT, US and MR imaging systems.

Expected Outcome

At the end of the course the students will be

i. Familiar with the principle and applications various analytical, diagnostic and therapeutic instruments
ii. Knowing the different methods and modalities used for medical imaging.

Text Books:

Joseph J. Carr, John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education (Singapore) Pvt. Ltd., 2001.

Reference Books:

1. Bronzino, Hand book of Biomedical Engineering, IEEE press book.
2. Geddes& Baker,' Principles of Applied Biomedical Instrumentation', Wiley
3. John G Webster (Ed), Encyclopedia of Medical Devices and Instrumentation ,Wiley
4. R.S Khandpur – Handbook of Biomedical Instrumentation – Tata McGraw
5. Webster J,' Medical Instrumentation-Application and Design', John Wiley

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Origin of bioelectric potentials – resting and action potentials - propagation of action potentials – Examples of bioelectric potentials - ECG, EEG, EMG, ERG, EOG, EGG – Electrodes for measurement of biopotentials.	3	15%
	Transducers for measurement of temperature, pressure & displacement - Basic principles only	3	
II	Electrical activity of heart, electrocardiogram - lead systems - ECG machine – block diagram	2	15%
	Cardiac pacemakers – internal and external pacemakers, defibrillators – basic principles. Measurement of heart sounds – phonocardiography	3	

	Measurement of blood pressure – sphygmomanometer & oscillometric methods. Photo plethysmography - for pulse rate measurement - Pulse oximeters	2	
	Holter recorders. Cardiac stress testing – methods & protocols Patient monitoring systems-Bed side & central station	2	
FIRST INTERNAL EXAM			
IV	Electrical activity of brain - Electro encephalogram – EEG measurement & waveforms - block diagram. Evoked potential - types & applications	3	**15%**
	Electrical activity of Muscle – Electromyogram (EMG) – Types of electrodes.	1	
	Spiro meter - measurement of respiratory parameters.	2	
III	Heart lung machine, Infant incubators, Infusion pumps, Artificial heart valves - Basic principles & block diagram only.	4	**15%**
	Lithotripsy – principles, types & applications. Surgical diathermy - Basic principles & block diagram only.	3	
SECOND INTERNAL EXAM			
V	X-ray radiography - Principles of x-ray generation – Block diagram of x-ray machine - Description. Angiography - Basic principles	3	**20%**
	X-ray computed tomography - Principle of operation, sectional imaging, scanner configurations. Reconstruction of images - Iterative & Fourier methods	5	
VI	Ultrasonic imaging – Basic principles - Ultrasonic transducers & Types - modes of image display-Principles & applications. Doppler & colour flow imaging	3	**20%**
	MRI – Basic Principles - FID signal-excitation & emission – Basic pulse sequences - Block diagram	3	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

There shall be three parts for the question paper.

Part A includes Modules 1 & 2 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part B includes Modules 3 & 4 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part C includes Modules 5 & 6 and shall have three questions of twenty marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Note: Each part shall have questions uniformly covering both the modules in it.

Course code	Course Name	L-T-P-Credits	Year of Introduction
BM484	MEDICAL IMAGING & IMAGE PROCESSING TECHNIQUES	3-0-0-3	2016

Course Objectives

- To introduce the underlying principles of biomedical imaging modalities such as US, X-ray, CT, SPECT, PET and MRI
- To provide an overview of the image processing techniques used in these images

Syllabus

Imaging Techniques – X-ray - CT, Nuclear medicine imaging modalities - SPECT and PET, Ultrasound Imaging - Doppler ultrasound, Magnetic resonance imaging –T1, T2 and Proton density weighted, Thermography and Microwave imaging, Image sampling and quantization, Image enhancement-spatial and frequency domain methods, Image segmentation-edge based and region based.

Expected Outcome

The students will be able to

i. Identify major processes involved in formation of medical images
ii. Recognize the imaging modality from their visualizations
iii. Classify the various medical image processing algorithms
iv. Describe fundamental methods for image enhancement and segmentation

Reference Books:

1. A C Kak, Principle of Computed Tomography, IEEE Press New York
2. Atam P Dhawan , Medical Imaging Analysis, Wiley Interscience publication, 2003
3. D L Hykes, W R Hedrick &D E Starchman: Ultrasound Physics &Instrumentation, Churchill Livingstone, Melbourne, 1985.
4. Douglas A Christensen: Ultrasonic Bioinstrumentation, John Wiley, New York, 1988.
5. Gonzalez Rafel C, Wintz Paul: Digital Image Processing, Addison Wesley.1993
6. Issac N Bankman, Handbook of Medical Imaging, Processing and Analysis, Academic Press, 2008
7. M N Rehani: Physics of Medical Imaging, Macmillian India Ltd., 1991.
8. Peter Fish, The Physics of Diagnostic Ultrasound, John Wiley &sons, Eng land,1990.
9. S Webb, The Physics of Medical Imaging, IOP Publishing Ltd., 1988.
10. Thomas M. Deserno : Biomedical Image Processing Springer-Verlag Berlin Heidelberg 2011

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	X-ray imaging – basic principles of image formation – block diagram of an x-ray machine. Digital radiography - basic principles.	3	15%
	X-ray Computed Tomography - basic principles, contrast scale, different generations of CT scanners, basic principles of image reconstruction.	4	
II	Ultrasonic imaging – Physical principles, Transducer parameters, Different modes - A-mode, M-mode (echocardiograph), B-mode. Principles of Doppler ultrasonic imaging.	4	15%

	Magnetic Resonance Imaging – Principles of MRI, T1 weighted , T2 weighted and proton density weighted images, applications of MRI	3	
FIRST INTERNAL EXAM			
III	Nuclear medicine imaging modalities - Emission Computed Tomography – SPECT & PET	4	**15%**
	Thermography- Physics of thermography, applications of thermography	3	
IV	Image sampling and quantization, Image enhancement in spatial domain-gray level transformations, histogram processing	4	**15%**
	Smoothing and sharpening, spatial filters	3	
SECOND INTERNAL EXAM			
V	Image enhancement in frequency domain- filtering- low pass high pass , band pass and band stop filters	4	**20%**
	Homomorphic filter, Zooming operation	3	
VI	Image segmentation - detection of discontinuities- point, line, edge, edge-based image segmentation- edge linking and boundary detection	4	**20%**
	Region based segmentation- region growing, region splitting and merging	3	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

There shall be three parts for the question paper.

Part A includes Modules 1 & 2 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part B includes Modules 3 & 4 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part C includes Modules 5 & 6 and shall have three questions of twenty marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Note: Each part shall have questions uniformly covering both the modules in it.

Course Code	Course Name	L-T-P	Credits	Year of Introduction
BT362	Sustainable Energy Processes	3-0-0	3	2016

Prerequisite: Nil

Course Objectives

- To introduce the current and potential future energy systems, covering resources, extraction, conversion, and applications, with emphasis on meeting regional and global energy needs in a sustainable manner.

Syllabus

Classification of energy, extraction, conversion, and applications of solar energy, wind energy, ocean energy, biomass energy, fuel cells and hydro-dynamic systems, merits and demerits of various energy systems, energy storage.

Expected outcome

Students who successfully complete this course should be able to

i. Identify global and Indian energy sources.
ii. Explain capture, conversion and application of solar and wind energy.
iii. Explain conversion of biomass to energy.
iv. Explain the capture of energy from oceans.
v. Explain fuel cells and energy storage routes.

Reference Books

1. Bansal N K, Kleemann M, Michael Meliss, *Renewable Energy Sources & Conversion Technology*, Tata McGraw Hill publishing Company, New Delhi, 1990.
2. Boyle, Godfrey, *Renewable Energy*, 3/e, Oxford University Press, 2012.
3. S P Sukhatme, *Solar Energy - Principles of Thermal Collection and Storage*, 2/e, Tata McGraw- Hill Publishing company, New Delhi,1996.
4. Pramod Jain, *Wind Energy Engineering*, McGraw Hill, 2011.
5. Donald L Klass, *Biomass for Renewable Energy, Fuels and Chemicals*, Academic Press, 1998.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**General classification of energy**. Conventional and non-conventional. Renewable and non-renewable. Global and Indian energy sources. Global and Indian energy consumption. Problems of fossil fuels. Environmental aspects of energy utilization. Energy and sustainable development. Energy planning. Renewable energy sources, potentials, achievements and applications.	7	15%
II	**Solar energy**. Solar radiation. Solar thermal systems. Flat plate and concentrating collectors. Solar desalination. Solar pond. Solar cookers. Solar dryers. Solar thermal electric power plant. Solar photovoltaic conversion. Semiconductor and thin film technology. Solar cells. Solar photovoltaic power generation. Hybrid systems. Merits and limitations of solar energy.	7	15%
FIRST INTERNAL EXAM			

III	**Wind energy**. Availability of wind energy, Site characteristics, Wind turbine types-horizontal axis and vertical axis-design principles of wind turbine. Wind power plants, Wind energy storage. Safety and environmental aspects. Merits and limitations of wind energy.	7	15%
IV	**Biomass energy**. Biomass resources, Biomass conversion technologies-direct combustion, pyrolysis, biomass gasification. Biogas production. Biomethanation as an aid to environment improvement. Bioethanol, biodiesel and biobutanol production. Hydrogen as fuel. Biohydrogen production. Storage of hydrogen.	7	15%
SECOND INTERNAL EXAM			
V	**Energy from the oceans**. Ocean thermal electric conversion. Tidal energy conversion. Geothermal energy conversion. Hydro power-global and Indian scenario. Positive and negative attributes of hydropower. Electricity from hydropower. Small hydropower.	7	20%
VI	**Fuel cells.** Alkaline fuel cells. Phosphoric acid fuel cell. Molten carbonate fuel cell. Solid oxide fuel cell, Solid polymer electrolyte fuel cell. Magneto-hydrodynamic systems. Electric vehicles. Energy storage routes like thermal, chemical, mechanical, electrical storage. Batteries.	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 hours

The question paper consists of Part A, Part B and Part C.

Part A consists of three questions of 15 marks each uniformly covering Modules I and II. The student has to answer two questions (15×2=30 marks).

Part B consists of three questions of 15 marks each uniformly covering Modules III and IV. The student has to answer two questions (15×2=30 marks).

Part C consists of three questions of 20 marks each uniformly covering Modules V and VI. The student has to answer two questions (20×2=40 marks).

For each question there can be a maximum of 4 subparts.

Course Code	Course Name	L-T-P	Credits	Year of Introduction
BT461	Design of Biological Wastewater Treatment Systems	3-0-0	3	2016

Prerequisite : Nil

Course Objectives

- To provide the necessary theoretical background for the design of most common biological waste treatment systems.

Syllabus

Characteristics and *impacts of wastewater on* the environment, basic design considerations, types of biological treatment processes and reactors, aerobic suspended growth systems, anaerobic digesters, design consideration for upflow anaerobic sludge blanket reactors, biogas production.

Expected outcome

A student who successfully completes this course will be able to

i. Explain the characteristics of wastewater.
ii. Identify different types of reactors for wastewater treatment.
iii. Design a completely mixed activated sludge system.
iv. Explain the design features of an upflow anaerobic sludge blanket reactor.
v. Explain the factors affecting biogas production.

Reference Books

1. G Karia, R A Christian, *Wastewater Treatment: Concepts and Design Approach*, 2/e, PHI Learning Pvt., Ltd., 2013.
2. P Venugopala Rao, *Textbook of Environmental Engineering*, Prentice-Hall of India Pvt. Ltd., 2002.
3. Metcalf & Eddy, *Wastewater Engineering: Treatment and Reuse*, 4/e, Tata McGraw-Hill Education, 2003.
4. M Narayana Rao, Amal K Datta, *Waste Water Treatment: Rational Methods of Design and Industrial Practices*, 3/e, Oxford & IBH Publishing Company Pvt. Ltd., New Delhi,
5. R S Khoiyangbam, Navindu Gupta, Sushil Kumar, *Biogas Technology: Towards Sustainable Development*, The Energy and Resources Institute (TERI), 2011.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Wastewater-origin, characteristics, *impacts of wastewater on* the environment, basic design considerations-estimation of wastewater quantities, variation in wastewater flow rates-average daily flow, maximum daily flow, peak hourly flow, minimum daily flow, minimum hourly flow, process flow sheet, reactor considerations.	5	15%
II	Objectives and fundamentals of biological treatment, types of biological treatment processes, types of reactors used for wastewater treatment process, kinetics of biological treatment systems-batch and continuous systems, biological nitrogen removal, biological phosphorous removal.	5	15%
FIRST INTERNAL EXAM			

III	Aerobic suspended growth systems-Conventional activated sludge processes and its modifications-theoretical principles, design of completely mixed activated sludge system, F/M ratio, hydraulic loading, MLSS, MLVSS, sludge age, sludge return, calculation of the reactor volume, production and removal of excess sludge, sludge volume index, Solids Retention Time (SRT) or Mean Cell Residence Time, oxygen requirements.	8	15%
IV	Aerobic attached growth system-Trickling filters-theoretical principles, classification, design principles, process design considerations, Oxidation ponds-construction and design considerations, aerobic sludge digestion, waste stabilization ponds, oxidation ditches-theory and design, factors affecting the design, theory and design of rotating biological contactors	8	15%
SECOND INTERNAL EXAM			
V	Fundamentals of anaerobic treatment, types of anaerobic digesters-conventional systems, high-rate systems and combined treatment systems, design of upflow anaerobic sludge blanket reactors, anaerobic sequencing batch reactor, anaerobic filters-upflow and downflow anaerobic filters, sludge treatment and disposal, sludge digestion, sludge drying, sludge conditioning, sludge drying characteristics.	8	20%
VI	Biogas technology-microbiology of biogas production, process parameters for a biogas plant, biogas yield from different substrates, methods to enhance biogas production-effect of heating, insulation and stirring on gas production, basic components of a biogas plant, biogas plant designs-continuous type plants, semi-continuous plants, fixed dome type, floating gasholder digester (KVIC),kinetic models for predicting biogas production, design equations of biogas plants.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 hours

The question paper consists of Part A, Part B and Part C.

Part A consists of three questions of 15 marks each uniformly covering Modules I and II. The student has to answer two questions (15×2=30 marks).

Part B consists of three questions of 15 marks each uniformly covering Modules III and IV. The student has to answer two questions (15×2=30 marks).

Part C consists of three questions of 20 marks each uniformly covering Modules V and VI. The student has to answer two questions (20×2=40 marks).

For each question there can be a maximum of 4 subparts.

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE482	ENVIRONMENTAL IMPACT ASSESSMENT	3-0-0-3	2016

Prerequisites: Nil

Courseobjectives:

- To study the various types of environmental pollution
- To study the impact of various types of pollutants and their assessment techniques

Syllabus:

Pollution, Types. Air pollution-sources, effects, types of pollutants. Water pollution, characteristics of water pollutants, Solid wastes, sources, types, soil pollution, pesticide pollution. Noise pollution, Impacts, positive and negative Environmental impact assessment, steps of doing EIA, methodology adopted, EIA procedure in India, Case studies.

Course Outcomes:

- The students will have a basic knowledge of various pollution sources and their impacts

Text Books / References:

1. B.C Punmia , "Waste Water Engineering", Laxmi Publications Pvt. Ltd,
2. Dr. PN Modi, "Sewage Treatment & Disposal and Waste water Engineering", Standard Book House, New Delhi
3. John Glasson, Riki Therivel & S Andrew Chadwick "Introduction to EIA" University College London Press Limited
4. Larry W Canter, "Environmental Impact Assessment", McGraw Hill Inc. , Newyork.
5. Mackenzie L Davis, Introduction to Environmental Engineering, McGraw hill Education (India)
6. Peavy H S, Rowe, D.R. Tchobanaglous "Environmental Engineering" Mc Graw Hill Education
7. Rau G J and Wooten C.D "EIA Analysis Hand Book" McGraw Hill
8. Robert A Corbett "Standard Handbook of Environmental Engineering" McGraw Hill

COURSE PLAN

Module	Contents	Hours	End Sem. Exam Marks %
I	INTRODUCTION: Classification of Pollution and Pollutants, AIR POLLUTION: Primary and Secondary Pollutants, air pollutants-sulfur dioxide- nitrogen dioxide, carbon monoxide, Impact of air pollutants on human, vegetation and environment, , Ambient Air Quality Standards	7	15
II	WATER POLLUTION: Point and Non-point Source of Pollution, Major Pollutants of Water, Physical, chemical and biological characteristics of water , Water borne diseases, Water Quality standards	7	15

FIRST INTERNAL EXAMINATION			
III	SOLID WASTE: Classification and sources of Solid Waste, Characteristics of Solid Waste, e waste, Radioactive wastes LAND/SOIL POLLUTION: Effects of urbanization on land degradation, Impact of Modern Agriculture on Soil, pesticide pollution, Effect on Environment	6	15
IV	NOISE POLLUTION: Sources of Noise, Effects of Noise, measurement of noise, Equivalent sound pressure level, Control measures	6	15,
SECOND INTERNAL EXAMINATION			
V	Impacts of pollutants, types, scale of impact-Global, local pollutants. Climate change, Ozone layer depletion, Deforestation, land degradation Environmental impact assessment, Need for EIA,	8	20
VI	EIA Procedure-Screening, Scoping, EIA procedure in India, Impact analysis- checklists, matrix methods, overlay analysis, Case studies of EIA	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (External Evaluation) :

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V &VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE484	APPLIED EARTH SYSTEMS	3-0-0-3	2016

Prerequisites: Nil

Course objectives:

- Appreciation of earth as a system of interrelated components
- Understanding mechanisms that give rise to oceanographic and atmospheric phenomena
- Comprehension of processes that result in characteristic land features in different climatic regimes

Syllabus :

Fundamental concepts of equilibrium - Geomorphic agents and processes -Earth systems -climate change - Weathering- Fluvial processes- Stages of stream development- Drainage patterns - Soil- Deserts- Wagner's ideas of continental drift, Plate Tectonics- Basics of oceanography-. Basic ideas about plankton and primary productivity -Basics of atmosphere and atmospheric processes - Heat budget- Fundamental concepts of precipitation, global wind patterns.

Expected Outcomes:

i. The students would understand the roles of surface and sub surface phenomena in shaping surface features of earth

ii. The course would appreciate the ramifications of any atmospheric, oceanographic or land process on other component subsystems including biosphere.

Text Books / References:

1. Critchfield H J ,*General Climatology* Prentice Hall, New Delhi, 1983
2. Fetter C W, *Applied Hydrogeology* CBS New Delhi, 1990
3. Carlson, D H, Plummer, CC and McGreary, D, *Physical geology: Earth Revealed* McGraw Hill, New York, 2006
4. Pinet P R, *Oceanography – An Introduction to the Planet Oceanus*, West Publishing Co., 1992
5. Valdiya K S, Environmental Geology: Ecology, Resource and Hazard Management McGraw-Hill Education (India) Private Limited, New Delhi, 2013

OURSE PLAN			
Module	**Contents**	**Hours**	**End Sem. Exam Marks %**
I	Fundamental concepts of equilibrium. Geomorphic agents and processes. Basic concept of Earth as a system and its component sub systems. Climate Change vis-a-vis the interrelationships of the subsystems- Green House Effect and Global warming, basic ideas about their causes and effects.	7	15
II	Weathering- relevance, influence of and on earth systems, types and controlling factors Fluvial processes-hydrological cycle, fluvial erosion, transportation and deposition, fluvial landforms. Stages of stream development; Drainage patterns.	7	15
FIRST INTERNAL EXAMINATION			
III	Soil- formation and controls, soil profile, soil erosion and conservation methods. Deserts-distribution and controls.	7	15
IV	Wagner's ideas of continental drift, Plate Tectonics- seafloor spreading. Plate boundaries and their features, mechanisms of plate movements.	7	15
SECOND INTERNAL EXAMINATION			
V	Basics of oceanography: coastal upwelling and downwelling. Outlines of ocean floor topography, Brief account of marine sediments, turbidity currents, basic outlines of origin and circulation of deep sea surface currents (Atlantic and Pacific Oceans), coral reefs- types and concepts about their formation. Basic ideas about plankton and primary productivity.	7	20
VI	Basics of atmosphere and atmospheric processes: Structure and composition of the atmosphere. Heat budget, factors affecting solar radiation. Fundamental concepts of precipitation, global wind patterns.	7	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End Semester Exam)

Maximum Marks : 100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V &VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-C	Year of Introduction
CE486	GEOINFORMATICS FOR INFRASTRUCTURE MANAGEMENT	3-0-0-3	2016

Prerequisites: Nil

Course objectives:

- To expose the concept of GIS and Remote sensing
- To introduce the applications of GIS and Remote sensing for infrastructure management

Syllabus:

Remote Sensing - Energy sources and radiation principles - Data acquisition - Multispectral, Thermal and Microwave remote sensing -; Elements of visual image interpretation- Introduction to Digital Image processing - Coordinate Systems – Map projections - GIS: Components of GIS - Data input and editing –GIS output- Data visualization -Digital Elevation Models and Digital Terrain Models – Mapping - Site suitability analysis - Network Analysis

Course Outcomes:

The students will

- Understand various satellite data products and their uses.
- Know about the Geospatial data and its importance in Spatialanalysis.
- Apply Geoinformatics techniques in various engineering applications and for infrastructure development.

Text Books / References:

1. Burrough P.P. &McDonnel, R.A. (1998) Principles of GIS, Oxford University Press
2. Chang, K (2008), Introduction to Geographic Information Systems, Tata McGraw-Hill
3. Davis, B. E. (2001), GIS: A visual approach, Onword Press
4. F.F Sabins(Jr.), Remote Sensing : Principals and Interpretation, Freeman & Co., San Francisco, 1978
5. Joseph, G., Fundamentals of Remote Sensing, Universities Press (2003)
6. Keith P.B., Thompson et. Al. (Ed.), Remote Sensing and Water Resources Management, American Water Resources Association, Urbana Illinois, 1973.
7. Kennie, T.J.M. and Matthews, M.C., Remote Sensing in Civil Engineering, Surrey University Press (1985)
8. Lo, C.P. and Albert Yeung , Concepts and Techniques of GIS , Prentice Hall, 2nd Ed. 2006
9. M Anji Reddy(2001), Remote Sensing and Geographic Information Systems, B S Publications, Hyderabad
10. Panigrahi,N (2008), Geographical Information Science, University Press
11. R.N. Colwel (Ed.), Manual of Remote Sensing, Vol. I & II, American Society of Photogrammetry and Remote Sensing, Falls Church, Va. (1983)
12. Schowengerdt, R. A.,Remote sensing, Models and Methods for image processing, Academic Press (2009)
13. T.M. Lillesand and R.W.Kiefer, Remote Sensing and Image Interpretation, John Wiley and Sons, 1979

COURSE PLAN

Module	Contents	Hours	End Sem Exam Marks %
I	Remote Sensing: Energy sources and radiation principles- Interaction of EM energy with atmosphere and surface features,	7	15

	spectral reflectance patterns, Data acquisition - Multistage and multispectral remote sensing concept		
II	Classification of Remote sensing systems - Optical, Thermal and Microwave remote sensing. Image Interpretation: Elements of visual image interpretation – Image interpretation keys - Introduction to Digital Image processing.	7	15
FIRST INTERNAL EXAMINATION			
III	Coordinate Systems: Geographic coordinate systems- approximations of earth, ellipsoid and geoid models, geodetic datum and vertical datum, coordinate transformation, Map projections-concepts, properties, and types.	7	15
IV	GIS: Geographical concepts and terminology, Components of GIS, Spatial and non-spatial data, Vector and raster data; Methods of data input, Spatial data editing; Vector data analysis-buffering, overlay, slivers; Raster data analysis- categories; GIS output: cartographic and non-cartographic output	7	15
SECOND INTERNAL EXAMINATION			
V	Digital Elevation Models and Digital Terrain Models; Land use/ Land cover mapping, Ground Water Potential Zonation Mapping, Hazard Zonation Mapping.	7	20
VI	Site suitability analysis for Residential area, Industrial area, Recreational Area, Solid Waste Disposal, Water treatment plant Network Analysis- Water supply line, Sewer line, Power line, Telecommunication, Road network	7	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks : 100 **Duration : 3 hours**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V &VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE488	DISASTER MANAGEMENT	3-0-0-3	2016

Course Objectives

- To provide an overview of the common hazards and their dynamics
- To inculcate the basic concepts of disaster management

Syllabus

Fundamental concepts of hazards and disasters - Basic concept of Earth as a system and its component sub systems - . Climate Change - Introduction to key concepts and terminology of hazard, vulnerability, exposure, risk, crisis, emergencies, Disasters, Resilience - Natural Disasters - Earth quakes, Landslides. Floods, Coastal disasters, Tidal waves, Tsunamis. Nature of Impacts - Anthropogenic Disasters – Soil degradation and desertification -water and atmospheric pollution -Hazard and disaster management plans for floods, tidal waves.

Expected Outcome

The students will

i. get general ideas about the processes involved in natural and anthropogenic disasters
ii. understand the concepts of disaster management and measures to mitigate and contain common episodes of disasters

References:

1. Andrew, S., "Environmental Modeling with GIS and Remote Sensing", John Willey and sons, 2002
2. Ariyabandu, M. and Sahni P. (Eds), "Disaster Risk Reduction in South Asia", Prentice-Hall (India), 2003.
3. Bell, F.G., "Geological Hazards: Their assessment, avoidance and mitigation", E & FN SPON Routledge, London. 1999
4. Bossler, J.D., "Manual of Geospatial Science and Technology", Taylor and Francis, London, 2001
5. David Alexander, "Natural Disasters", Research Press, New Delhi, 1993
6. Matthews, J.A., "Natural hazards and Environmental Change", Bill McGuire, Ian Mason, 2002
7. Nick Carter. W., "Disaster Management - A Disaster Manager's Handbook". Asian Development Bank, Philippines. 1991
8. United Nations , Mitigating Natural Disasters, Phenomena, Effects and options, A Manual for policy makers and planners, New York, 1991

COURSE PLAN

Module	Contents	Hours	End Sem. Exam Marks
I	Fundamental concepts of hazards and disasters: Introduction to key concepts and terminology of hazard, vulnerability, exposure, risk, crisis, emergencies, Disasters, Resilience. Basic concept of Earth as a system and its component sub systems. Climate Change vis-a-vis the interrelationships of the subsystems- Green House Effect and Global warming, basic	7	15%

	ideas about their causes and effects.		
II	Types of Natural Disasters I- Earth quakes, Landslides. Nature of impacts.	7	15%
FIRST INTERNAL EXAMINATION			
III	Types of Natural Disasters II- Floods, Coastal disasters- Cyclones, Tsunamis. Nature of impacts.	7	15%
IV	Types of Anthropogenic Disasters I– soil and soil degradation, desertification.	7	15%
SECOND INTERNAL EXAMINATION			
V	Types of Anthropogenic Disasters II-Fundamental concepts of water and atmospheric pollution.	7	20%
VI	Hazard and disaster management plans for floods, tidal waves.	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End Semester Examination)

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V &VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE494	ENVIRONMENTAL HEALTH AND SAFETY	3-0-0-3	2016

Pre-requisites: Nil

Courseobjectives:

- To introduce the different types of hazards in industries and the management of hazards.
- To learn the various types of pollution.

Syllabus:

Occupational health and toxicology- Lead-nickel, chromium and manganese toxicity-gas poisoning-Industrial hygiene, Physical, chemical and biological hazards, Safety and Health Management, noise-effects, source, Electrical Hazards and Hazards in Construction Industry, Air pollution, Water pollution, Hazardous Waste Management, pollution control in different industries

Expected Outcomes:

The students will

i. Be able to understand the various occupational hazards and the techniques that can be adopted for managing hazards and related problems

ii. Become aware regarding air pollution and water pollution problems and pollution control in industries

Text Books / References:

1. Gerard Kiely, Environmental Engineering, McGraw hill Education
2. Mackenzie L Davis, Introduction to Environmental Engineering, McGraw hill Education (India)
3. National Safety Council , Hand book of Occupational Safety and Health, Chicago, 1982
4. R.K.Jain and Sunil S.Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers , New Delhi (2006)
5. S.P.Mahajan, "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 1993
6. Slote.L, Handbook of Occupational Safety and Health, John Willey and Sons, NewYork

COURSE PLAN

Module	Contents	Hours	End Sem. Exam Marks
I	Occupational Health And Toxicology : occupational related diseases, silicosis, asbestosis, pneumoconiosis, etc. lead, nickel, chromium and manganese toxicity, effects and prevention –Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects. Industrial Hygiene.	7	15%

II	Noise, noise exposure regulation. Ionizing radiation, types, effects. Chemical hazards-dust, fumes, mist, vapour, fog, gases, Methods of Control. Biological hazards-Classification of Biohazardous agents – bacterial agents, viral agents, fungal, parasitic agents, infectious diseases.	7	15%
FIRST INTERNAL EXAMINATION			
III	Radiation and Industrial Hazards, Types and effects of radiation on human body, disposal of radioactive waste Air Pollution - air pollutants from industries, effecton human health, animals, Plants and Materials - concept of clean coal combustion technology - depletion of ozone	6	15%
IV	Electrical Hazards, Protection against voltage fluctuations, Effects of shock on human body. Introduction of Construction industry, Scaffolding and Working platform, Welding and Cutting, Excavation Work, Concreting and Cementing work, Transportation of men and material,	6	15%
SECOND INTERNAL EXAMINATION			
V	Water Pollution -water pollutants-health hazards - effluent quality standards,tannery, textile effluents Hazardous Waste Management -waste identification, characterization and classification, health hazards-toxic and radioactive wastes-recycling and reuse.	8	20%
VI	Pollution Control In Process Industries - Pollution control in process industries like cement, paper, petroleum products-textile, tanneries-thermal power plants – dyeing and pigment industries - eco-friendly energy.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (External Evaluation) :

Maximum Marks :100 **Exam Duration: 3 Hrs**

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V &VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course code	Course Name	L-T-P-Credits	Year of Introduction
CH482	PROCESS UTILITIES AND PIPE LINE DESIGN	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

1. To impart the basic concepts of project engineering
2. To develop understanding about process auxiliaries and utilities in process industries

Syllabus

Process Auxiliaries. Piping design, Piping insulation, Piping fittings, Valves, Pumps, Process control and instrumentation diagram.
Process Utilities: Process Water, Steam, Compressors and Vacuum Pumps, Methods of vacuum development and their limitations, materials handling under vacuum. Refrigeration and Chilling systems, Oil heating systems, Nitrogen systems

Expected Outcome

After successful completion of the course the students will be able to

i. Acquire the overall knowledge about the process plant.
ii. Understand the importance of process auxiliaries and utilities in process industries.
iii. Learn the conceptual design of chemical process plant.
iv. Build a bridge between theoretical and practical concepts used for process auxiliaries and utilities in any process industry.

References:

1. F.C. Vibrandt and C.E. Dryden, "Chemical Engineering Plant Design", McGraw Hill, Fifth Edition.
2. Jack Broughton; Process utility systems; Institution of Chem. Engineers, U.K.
3. M.S. Peters and Timmerhaus, "Plant design and Economics for Chemical Engineers", Mc Graw Hill 3rd Edition.
4. Roger Hunt and Ed Bausbacher, "Process Plant layout and Piping Design" PTR Prentice-Hall Inc.,

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Process Auxiliaries: Basic considerations and flow diagrams in chemical engineering plant design. Piping design: Selection of material, pipe sizes, working pressure, Basic principles of piping design, piping drawings, pipe installations, overhead installations, Process steam piping, selection and determination of steam – pipe size, Piping insulation, application of piping insulation, weather proof and fire resisting pipe insulation jackets, piping fittings, pipe joints	7	15
II	Valves: Types of valves, selection criteria of valves for various systems. Pumps: Types of pumps, NPSH requirement, pump location, pump piping, pump piping support. Process control and instrumentation diagram, control system design for process auxiliaries.	7	15

FIRST INTERNAL EXAMINATION			
III	Process Utilities: Process Water: Sources of water, hard and soft water, Requisites of industrial water and its uses, Methods of water treatment, Chemical softening, Demineralization, Resins used for water softening, Water for boiler use, cooling purposes, cooling towers, drinking and process water treatment, reuse and conservation of water, 27 50% water resources management, waste water treatment and disposal.	7	15
IV	Steam: Steam generation and its application in chemical process plants, distribution and utilization, boilers, design of efficient steam heating systems, steam economy, condensate utilization, steam traps, their characteristics, selection and application, waste heat utilization	7	15
SECOND INTERNAL EXAMINATION			
V	Compressors and Vacuum Pumps: Types of compressors and vacuum pumps and their performance characteristics, Methods of vacuum development and their limitations, materials handling under vacuum, lubrication and oil removal in compressors and pumps, instrument air.	7	20
VI	Refrigeration and Chilling systems. Oil heating systems, Nitrogen systems.	7	20
END SEMESTEREXAMINATION			

Question Paper Pattern:

Maximum Marks: 100 Exam Duration: 3 Hours

Part A: There shall be **Three questions** uniformly covering Modules 1 and 2, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together.
(2 x15= 30 Marks)

Part B: There shall be **Three questions** uniformly covering Modules 3 and 4, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together.
(2 x15= 30 Marks)

Part C: There shall be **Three questions** uniformly covering Modules 5 and 6, each carrying 20 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 20 marks for all the subdivisions put together.
(2 x20= 40 Marks)

Course code	Course Name	L-T-P-Credits	Year of Introduction
CH484	FUEL CELL TECHNOLOGY	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To expose the students to the fundamental knowledge required in the development of fuel cell technology.

Syllabus

Introduction to Fuel Cells and Fuel Cell Technology, General Thermodynamics, Reaction Kinetics, Charge and Mass Transport, Overview of Fuel Cell Types, Stack Design, Fuel Cell Characterization, Hydrogen Economy.

Expected Outcome

At the end of the course the students will be able to:

1. Know the fundamentals of electrochemistry, thermodynamics, fluid mechanics, and heat and mass transfer, appropriate for the design or review of components of fuel cells and fuel cell systems.
2. Analyze the fuel cell technology and compare different types of fuel cell systems.
3. Calculate the various losses in fuel cells and analyze the fuel cell power plant subsystems.
4. Defend the significance of fuel cell technology in the new global energy scenario.
5. Distinguish the expectances of hydrogen as a fuel and energy vector in the context of renewable energy.

References Books:

1. Andreas Zuttel; Andreas Borgschulte; Louis Schdaptach, Hydrogen as a future energy carrier, Wiley-VCH Verlag GmbH & Co., KGaA, Weinheim, 2008.
2. Costamagna, P.; Srinivasan, S, J Power Sources 2001, 102, 242-269..
3. Frano Barbir. PEM Fuel Cells: Theory and Practice. Elsevier, 2005
4. Fuel Cell Handbook,7the Edn., EG & G Technical Services, Nov 2004
5. Hordeski, M. F. Alternative Fuels: The Future of Hydrogen, The Fairmont Press: Lilburn, GA, 2007.
6. Kordesch, K.; Simader, G. Fuel Cells and Their Applications. VCH: 1996
7. Larminie, J.; Dicks, A. Fuel Cell Systems Explained. John Wiely & Sons Ltd: Chichester, 1999.
8. Ryan P. O'Hayre, Suk-Won Cha, Whitney Colella & Fritz B. Printz, Fuel Cell Fundamentals, John Wiley & Sons, Inc., New Jersey, 2006
9. Vielstich, W, Gasteiger, H. A. Lamm, A. (Eds):Handbook of Fuel Cells-Fundamentals, Technology and Applications. John Wiely & Sons Ltd: NY, 2003; Vols1-4

Course Plan

Module	Contents	Hours	Sem. exam marks
I	**Introduction:** Fuel Cell, Brief History of fuel cells, Types of Fuel Cells, Working of a PEM fuel Cell, Fuel Cell and conventional processes – comparison, Energy & power relations, units, Application scenarios, Advantages and disadvantages.	7	15%

	General Thermodynamics: Enthalpy-Heat potential of fuel, Gibb's free energy-Work potential of fuel, Reversible voltage - NERNST Equation, Voltage and P, T and concentration dependence – examples, Faraday's Laws, Efficiency: thermodynamic, voltage and fuel.		
II	**Reaction Kinetics**: Electrochemical reaction fundamentals, electrode kinetics, Charge transfer and activations energy, Exchange current density - slow and fast reactions, Potential and equilibrium - galvanic potential, Reaction rate and potential - Butler Volmer equation & Tafel equation, Electrocatalysts and reaction kinetics – typical exchange current densities, Electrode design basics	7	15%
FIRST INTERNAL EXAMINATION			
III	**Charge and Mass Transport**: Charge transport resistances, voltage losses, Ionic and electronic conductivites, Ionic conduction in different FC electrolytes: Aquesous, polymeric and ceramic, Diffusive transport & voltage loss: Limiting current density, Nerstian and kenetic effect, Convective transport: flow channels, gas diffusion / porous layer, gas velocity, pressure, Flow channel configurations	7	20%
IV	Overview of Fuel Cell Types: PAFC, PEMFC, AFC, MCFC, SOFC. Major Cell Components, Material Properties, Processes and Operating Conditions of PEMFC.	7	20%
SECOND INTERNAL EXAMINATION			
V	**Stack Design**: Sizing of a Fuel Cell Stack, Stack Configuration, Uniform distribution of Reactants, Heat removal, Stack Clamping **Fuel Cell Diagnostics**: Polarization Curve, Current Interrupt, AC Impedance Spectroscopy, Pressure drop as a diagnostic tool.	7	15%
VI	**Fuel Cell System Design**: Hydrogen-Oxygen Systems, Hydrogen-Air Systems, Fuel Cell Systems with Fuel Processor, System Efficiency **Fuel Cells and Hydrogen Economy**: Hydrogen Energy Systems, Hydrogen Energy Technologies, Transition to Hydrogen Economy	7	15%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum Marks: 100 Exam Duration: 3 Hours

Part A: There shall be **Three questions** uniformly covering Modules 1 and 2, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together.
(2 x15= 30 Marks)

Part B: There shall be **Three questions** uniformly covering Modules 3 and 4, each carrying 20 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 20 marks for all the subdivisions put together.
(2 x20= 40 Marks)

Part C: There shall be **Three questions** uniformly covering Modules 5 and 6, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together.
(2 x15= 30 Marks)

Course code	Course Name	L-T-P-Credits	Year of Introduction
CS482	DATA STRUCTURES	3-0-0-3	2016

Pre-requisite: A course on C or C++ in the B-Tech level with emphasis on pointers and functions.

Course Objectives:

- To introduce linear data structures such as stacks, queues and their applications.
- To introduce non-linear data structures such as trees, graphs and their applications.
- To impart various sorting, searching and hashing techniques and their performance comparison.

Syllabus:

Introduction to various programming methodologies, terminologies and basics of algorithms analysis, Basic Abstract and Concrete Linear Data Structures, Non-linear Data Structures, Sorting Algorithms, Searching Algorithms, Hashing.

Expected Outcome:

The Student will be able to:-

i. compare different programming methodologies and define asymptotic notations to analyze performance of algorithms
ii. choose appropriate data structures like arrays, linked list, stacks and queues to for practical scenarios
iii. represent and manipulate data using nonlinear data structures like trees and graphs to design algorithms for various applications
iv. illustrate and compare various techniques for searching and sorting
v. illustrate various hashing techniques

Text Books:

1. Richard F. Gilberg and Behrouz A. Forouzan, Data Structures: A Pseudocode Approach with C, 2/e, Cengage Learning, 2005.
2. Samanta D., Classic Data Structures, Prentice Hall India, 2/e, 2009.

References:

1. Aho A. V., J. E. Hopcroft and J. D. Ullman, Data Structures and Algorithms, Pearson Publication,1983.
2. Horwitz E., S. Sahni and S. Anderson, Fundamentals of Data Structures in C, University Press (India), 2008.
3. Hugges J. K. and J. I. Michtm, A Structured Approach to Programming, PHI, 1987.
4. Lipschuts S., Theory and Problems of Data Structures, Schaum's Series, 1986.
5. Martin Barrett, Clifford Wagner, And Unix: Tools For Software Design, John Wiley, 2008
6. Peter Brass, Advanced Data Structures, Cambridge University Press, 2008
7. Tremblay J. P. and P. G. Sorenson, Introduction to Data Structures with Applications, Tata McGraw Hill, 1995.
8. Wirth N., Algorithms + Data Structures = Programs, Prentice Hall, 2004.

COURSE PLAN

Module	Contents	Hours	End Sem. Exam Marks

I	Introduction to programming methodologies – structured approach, stepwise refinement techniques, programming style, documentation – analysis of algorithms: frequency count, definition of O notation, asymptotic analysis of simple algorithms. Recursive and iterative algorithms.	**06**	**15%**
II	Abstract and Concrete Data Structures- Basic data structures – Arrays, Linked lists:- singly linked list, doubly linked list, Circular linked list, operations on linked list, linked list with header nodes, applications of linked list: polynomials,.	**07**	**15%**
FIRST INTERNAL EXAMINATION			
III	Implementation of Stacks and Queues using arrays and linked lists, Applications. Trees: - m-ary Tree, Binary Trees – level and height of the tree, complete-binary tree representation using array, tree traversals (Recursive only), applications.	**07**	**15%**
IV	Binary search tree – creation, insertion and deletion and search operations, applications. Heaps- Min-max heaps, Graphs – representation of graphs, BFS and DFS (analysis not required) applications.	**06**	**15%**
SECOND INTERNAL EXAMINATION			
V	Minimum Spanning Trees – Prim's and Kruskal algorithms. Shortest path algorithms – Djikstra and Warshall algorithms Sorting techniques – Bubble sort, Selection Sort, Insertion sort, Merge sort, Quick sort, Searching algorithms (Performance comparison expected. Detailed analysis not required)	**07**	**20%**
VI	Linear and Binary search. (Performance comparison expected. Detailed analysis not required) Hash Tables – Hashing functions – Mid square, division, folding, digit analysis, collusion resolution and Overflow handling techniques.	**07**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern (End semester exam)

1. There will be ***FOUR*** parts in the question paper – **A, B, C, D**
2. **Part A**
   a. **Total marks : 40**
   b. ***TEN*** questions, each have **4 marks**, covering **all the SIX modules** (***THREE*** questions from **modules I & II**; ***THREE*** questions from **modules III & IV**; ***FOUR*** questions from **modules V & VI**).
   All the TEN questions have to be answered.
3. **Part B**
   a. **Total marks : 18**
   b. ***THREE*** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question ***uniformly*** covers **modules I & II**.
   c. ***Any TWO*** questions have to be answered.
   d. Each question can have ***maximum THREE*** subparts.

4. **Part C**
    a. **Total marks : 18**
    b. ***THREE*** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question ***uniformly*** covers **modules III & IV**.
    c. ***Any TWO*** questions have to be answered.
    d. Each question can have ***maximum THREE*** subparts.
5. **Part D**
    a. **Total marks : 24**
    b. ***THREE*** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question ***uniformly*** covers **modules V & VI**.
    c. ***Any TWO*** questions have to be answered.
    d. Each question can have ***maximum THREE*** subparts.
6. There will be ***AT LEAST* 60%** analytical/programming/numerical questions in all possible combinations of question choices.

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2014

Course code	Course Name	L-T-P Credits	Year of Introduction
CS484	COMPUTER GRAPHICS	3-0-0-3	2016

Pre-requisite: A course on C or C++ in the B-Tech level with emphasis on pointers and functions.

Course Objectives

- To introduce concepts of graphics input and display devices.
- To introduce and discuss line and circle drawing algorithms.
- To introduce 2D and 3D transformations and projections.

Syllabus

Basic Concepts in Computer Graphics. Input devices. Display devices. Line/Circle Drawing Algorithms. Solid area scan-conversion. Polygon filling. Two dimensional transformations. Windowing, clipping. 3D Graphics, 3D transformations. Projections – Parallel, Perspective. Hidden Line Elimination Algorithms.

Expected Outcome:

The Student will be able to:-

i. compare various graphics devices
ii. analyze and implement algorithms for line drawing, circle drawing and polygon filling
iii. apply geometrical transformation on 2D and 3D objects
iv. analyze and implement algorithms for clipping
v. apply various projection techniques on 3D objects
vi. summarize visible surface detection methods

Text Books:

1. Donald Hearn and M. Pauline Baker, Computer Graphics, PHI, 1996
2. William M. Newman and Robert F. Sproull, Principles of Interactive Computer Graphics, McGraw Hill, 1979
3. Zhigang Xiang and Roy Plastock , Computer Graphics (Schaum's outline Series), 1986.

References

1. David F. Rogers , Procedural Elements for Computer Graphics, McGraw Hill, 2001
2. M. Sonka, V. Hlavac, and R. Boyle, Image Processing, Analysis, and Machine Vision, Thomson India Edition, 2007.
3. Rafael C. Gonzalez and Richard E.Woods , Digital Image Processing, Pearson, 2017 .

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Basic concepts in Computer Graphics – Types of Graphic Devices – Interactive Graphic inputs – Raster Scan and Random Scan Displays.	6	15%
II	Line Drawing Algorithm- DDA, Bresenham's algorithm – Circle Generation Algorithms –Mid point circle algorithm, Bresenham's algorithm-	7	15%
FIRST INTERNAL EXAM			

III	Scan Conversion-frame buffers – solid area scan conversion – polygon filling algorithms Two dimensional transformations. Homogeneous coordinate systems – matrix formulation and concatenation of transformations.	7	15%
IV	Windowing concepts –Window to Viewport Transformation- Two dimensional clipping-Line clipping – Cohen Sutherland, Midpoint Subdivision algorithm	6	15%
SECOND INTERNAL EXAM			
V	Polygon clipping- Sutherland Hodgeman algorithm, Weiler-Atherton algorithm, Three dimensional object representation- Polygon surfaces, Quadric surfaces – Basic 3D transformations	7	20%
VI	Projections – Parallel and perspective projections – vanishing points. Visible surface detection methods– Back face removal- Z-Buffer algorithm, A-buffer algorithm, Depth-sorting method, Scan line algorithm.	7	20%
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

1. There will be ***FOUR*** parts in the question paper – **A, B, C, D**
2. **Part A**
   a. **Total marks : 40**
   b. ***TEN*** questions, each have **4 marks**, covering **all the SIX modules** (***THREE*** questions from **modules I & II**; ***THREE*** questions from **modules III & IV**; ***FOUR*** questions from **modules V & VI**).
   All the TEN questions have to be answered.
3. **Part B**
   a. **Total marks : 18**
   b. ***THREE*** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question ***uniformly*** covers **modules I & II**.
   c. ***Any TWO*** questions have to be answered.
   d. Each question can have ***maximum THREE*** subparts.
4. **Part C**
   a. **Total marks : 18**
   b. ***THREE*** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question ***uniformly*** covers **modules III & IV**.
   c. ***Any TWO*** questions have to be answered.
   d. Each question can have ***maximum THREE*** subparts.
5. **Part D**
   a. **Total marks : 24**
   b. ***THREE*** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question ***uniformly*** covers **modules V & VI**.
   c. ***Any TWO*** questions have to be answered.
   d. Each question can have ***maximum THREE*** subparts.
6. There will be ***AT LEAST* 50%** analytical/numerical questions in all possible combinations of question choices.

Course code	Course Name	L-T-P - Credits	Year of Introduction
CS486	OBJECT ORIENTED PROGRAMMING	3-0-0-3	2016

Pre-requisite: A course on C or C++ in the B-Tech level with emphasis on pointers and functions.

Course Objectives:

- To impart the basic concepts of object oriented design techniques.
- To introduce the concepts and constructs of Java language.
- To introduce the basics of multithreading, network programming, database connectivity etc.
- To impart the techniques of creating GUI based applications.

Syllabus:

Object oriented concepts-Java Overview, Classes and objects, Parameter passing, Overloading, Inheritance, Overriding, Packages, Exception Handling, Input/Output, Threads and multithreading, Network programming using stream and datagram sockets, Applets, Event Handling mechanism, Working with frames and graphics, AWT Controls, Swings, Java database connectivity.

Expected Outcome:

The Student will be able to:

i. apply object oriented principles in software design process
ii. develop multithreaded client/server applications using socket programming
iii. create GUI based applications with database at back end

Text Book:

1. Balagurusamy E., Programming JAVA a Primer, 5/e, McGraw Hill, 2014
2. Herbert Schildt, Java: The Complete Reference, 8/e, Tata McGraw Hill, 2011.

References:

1. Barclay K. and J. Savage, Object Oriented Design with UML and Java, Elsevier, 2004.
2. Flanagan D., Java in A Nutshell, 5/e, O'Reilly, 2005.
3. Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008.
4. Sierra K., Head First Java, 2/e, O'Reilly, 2005.
5. Y. Daniel Liang, Introduction to Java Programming, 7/e, Pearson, 2013.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Object oriented concepts- Features of Object oriented programming – Encapsulation -data hiding , polymorphism, inheritance – types of inheritance – Dynamic linking- Introduction to Java- bytecodes- Java virtual machine,- Salient features of Java, Java programming -Data types, operators, control statements, Arrays,	06	
II	Classes fundamentals, objects, methods, constructors, parameter passing, overloading, access control keywords, static variables and methods, nested classes.	07	15%
FIRST INTERNAL EXAMINATION			

III	Inheritance basics, method overriding, abstract classes, interfaces. Defining and importing packages. Exception handling fundamentals, multiple catch and nested try statements.	06	15%
IV	Input/Output: files, stream classes, reading console input. Threads: thread model, use of Thread class and Runnable interface, thread synchronization, multithreading.	06	15%
SECOND INTERNAL EXAMINATION			
V	Strings in Java. Applet basics and methods. Event Handling: delegation event model, event classes, sources, listeners.	07	20%
VI	Introduction to AWT: working with frames, graphics, color, font. AWT Control fundamentals. Swing overview. Java database connectivity: JDBC overview, creating and executing queries	08	20%
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

1. There will be ***FOUR*** parts in the question paper – **A, B, C, D**
2. **Part A**
   a. **Total marks : 40**
   b. ***TEN*** questions, each have **4 marks**, covering **all the SIX modules** (***THREE*** questions from **modules I & II**; ***THREE*** questions from **modules III & IV**; ***FOUR*** questions from **modules V & VI**).
   All the TEN questions have to be answered.
3. **Part B**
   a. **Total marks : 18**
   b. ***THREE*** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question ***uniformly*** covers **modules I & II**.
   c. ***Any TWO*** questions have to be answered.
   d. Each question can have ***maximum THREE*** subparts.
4. **Part C**
   a. **Total marks : 18**
   b. ***THREE*** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question ***uniformly*** covers **modules III & IV**.
   c. ***Any TWO*** questions have to be answered.
   d. Each question can have ***maximum THREE*** subparts.
5. **Part D**
   a. **Total marks : 24**
   b. ***THREE*** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question ***uniformly*** covers **modules V & VI**.
   c. ***Any TWO*** questions have to be answered.
   d. Each question can have ***maximum THREE*** subparts.
6. There will be ***AT LEAST* 60%** analytical/programming/numerical questions in all possible combinations of question choices.

Course code	Course Name	L-T-P - Credits	Year of Introduction
CS488	C# AND .NET PROGRAMMING	3-0-0-3	2016

Pre-requisite: A course on C or C++ in the B-Tech level with emphasis on pointers and functions.

Course Objectives:

- To introduce C# and learn how object oriented programs can be developed using C#.
- To introduce the .NET framework and learn how web based applications can be designed and developed on it.

Syllabus:

Introduction To **C#,** Object Oriented Aspects of **C#,** Application Development On .NET, The CLR and The .NET Framework

Expected Outcome:

The Student will be able to:

i. apply principles of C# in object oriented programming
ii. develop programs in C# for implementing solutions
iii. develop web applications using the .NET framework

Text Books:

1. Andrew Troelsen , C# and the .NET Platform, 2/e, A! Press, Wiky India, 2003.
2. J Liberty, O'Reilly, Programming C#, 2/e, Media publisher, 2002.

References:

1. E Balagurusamy, Programming in C#, Tata McGraw-Hill, 2004.
2. Herbert Schildt , The Complete Reference: C# , Tata McGraw-Hill, 2004.
3. Robinson et al, Professional C#, 2/e, Wrox Press, 2002.
4. S Thamarai Selvi, R Murugesan, A Textbook on C# , Pearson Education, 2003.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introducing C#, Understanding .NET, Overview of C#, Literals, Variables, Data Types, Operators, Expressions,	06	15%
II	Branching, Looping, Methods, Arrays, Strings, Structures, Enumerations. Classes, Objects, Inheritance, Polymorphism, Interfaces	07	15%
FIRST INTERNAL EXAMINATION			
III	Operator Overloading, Delegates, Events, Errors and Exceptions. Building Windows Applications Accessing Data with ADO.NET.	06	15%
IV	**P**rogramming Web Applications with Web Forms, Programming Web Services.` Assemblies, Versioning, Attributes, Reflection, Viewing MetaData	06	15%
SECOND INTERNAL EXAMINATION			

Course Plan			
Module	**Contents**	**Hours**	**End Sem. Exam Marks**
V	Type Discovery, Reflecting on a Type, Marshaling, Remoting, Understanding Server Object Types,	07	20%
VI	Specifying a Server with an Interface, Building a Server, Building the Client, Using Single Call, Threads.	08	20%
END SEMESTER EXAM			

Question Paper Pattern End semester exam)

1. There will be ***FOUR*** parts in the question paper – **A, B, C, D**
2. **Part A**
   a. **Total marks : 40**
   b. ***TEN*** questions, each have **4 marks**, covering **all the SIX modules** (***THREE*** questions from **modules I & II**; ***THREE*** questions from **modules III & IV**; ***FOUR*** questions from **modules V & VI**).
   All the TEN questions have to be answered.
3. **Part B**
   a. **Total marks : 18**
   b. ***THREE*** questions, each having **9 marks**. One question is from **module I**; one question is from **module II**; one question ***uniformly*** covers **modules I & II**.
   c. ***Any TWO*** questions have to be answered.
   d. Each question can have ***maximum THREE*** subparts.
4. **Part C**
   a. **Total marks : 18**
   b. ***THREE*** questions, each having **9 marks**. One question is from **module III**; one question is from **module IV**; one question ***uniformly*** covers **modules III & IV**.
   c. ***Any TWO*** questions have to be answered.
   d. Each question can have ***maximum THREE*** subparts.
5. **Part D**
   a. **Total marks : 24**
   b. ***THREE*** questions, each having **12 marks**. One question is from **module V**; one question is from **module VI**; one question ***uniformly*** covers **modules V & VI**.
   c. ***Any TWO*** questions have to be answered.
   d. Each question can have ***maximum THREE*** subparts.
6. There will be ***AT LEAST* 60%** analytical/programming/numerical questions in all possible combinations of question choices.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC482	Biomedical Engineering	3-0-0-3	2016

Prerequisite: Nil

Course objectives:

- To introduce basics of biomedical engineering technology
- To understand the anatomy & physiology of major systems of the body in designing equipment for medical treatments.
- To impart knowledge about the principle and working of different types of bio-medical electronic equipment/devices.

Syllabus:

Human body-overview, Physiological systems of body, Measurement of physiological parameters, Assisting and therapeutic devices, Medical laboratory equipments, Telemetry in patient care, Patient safety, Medical imaging system

Expected outcome:

The students will be able:

i. To understand diagnosis and therapy related equipments.
ii. To understand the problem and identify the necessity of equipment for diagnosis and therapy.
iii. To understand the importance of electronics engineering in medical field.
iv. To understand the importance of telemetry in patient care

Text Books:

1. K S Kandpur, "Hand book of Biomedical instrumentation", Tata McGraw Hill 2nd e/d.
2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, PHI, 2nd Edition, 2004

References:

1. Barbara Christe, Introduction to Biomedical Instrumentation, Cambridge University Press, 2008.
2. J J Carr, "Introduction to Biomedical Equipment Technology", 4ed, Pearson Education
3. John G Webster, "Medical Instrumentation application and design", 3ed,John Wiley
4. Richard Aston, "Principle of Biomedical Instrumentation and Measurement", Merrill Education/Prentice Hall.

Course Plan

Module	Course content	Hours	End Sem. Exam Marks
I	Introduction to bio-medical instrumentation system, overview of anatomy and physiological systems of the body.	1	15%
	Sources of bio-electric potential: Resting and action potential, propagation of action potentials. Bioelectric potentials examples (ECG, EEG, EMG, ERG, EOG, EGG, etc introduction only.)	2	

	Electrode theory: Nernst relation Bio potential electrodes: Microelectrodes, skin surface electrodes, needle electrodes.	1	
	Instrumentation for clinical laboratory: Bio potential amplifiers- instrumentation amplifiers, carrier amplifiers, isolation amplifiers, chopper amplifiers	2	
II	Heart and cardiovascular system (brief discussion), electro conduction system of the heart. Electrocardiography, ECG machine block diagram, ECG lead configurations, ECG recording system, Einthoven triangle, analysis of ECG signals.	3	**15%**
	Measurement of blood pressure: Direct, indirect and relative methods of blood pressure measurement, auscultatory method, oscillometric and ultrasonic non-invasive pressure measurements.	2	
	Measurement of blood flow: Electromagnetic blood flow meters and ultrasonic blood flow meters.	2	
FIRST INTERNAL EXAM			
III	The human nervous system. Neuron, action potential of brain, brain waves, types of electrodes, placement of electrodes, evoked potential, EEG recording, analysis of EEG.	2	**15%**
	Electromyography: Nerve conduction velocity, instrumentation system for EMG.	1	
	Physiology of respiratory system (brief discussion), Respiratory parameters, spirometer, body plethysmographs, gas exchange and distribution.	2	
	Instruments for clinical laboratory: Oxymeters, pH meter, blood cell counter, flame photometer, spectrophotometer	3	
IV	Therapeutic Equipments: Principle, block schematic diagram, working and applications of: pacemakers, cardiac defibrillators, heart–lung machine, dialyzers, surgical diathermy equipment, ventilators	6	**15%**
SECOND INTERNAL EXAM			
V	Medical Imaging systems (Basic Principle only): X-ray imaging - Properties and production of X-rays, X-ray machine, applications of X-rays in medicine.	2	**20%**
	Computed Tomograpy: Principle, image reconstruction, scanning system and applications.	2	
	Ultrasonic imaging systems: Basic pulse echo system, propagation of ultrasonic through tissues and reflections, display types, A-Scan, B-Scan, M-Scan, applications, real-time ultrasonic imaging systems and probes.	3	
VI	Magnetic Resonance Imaging – Basic NMR components, Biological effects and advantages of NMR imaging	3	**20%**

	Biomedical Telemetry system: Components of biotelemetry system, application of telemetry in medicine, single channel telemetry system for ECG and temperature	2	
	Patient Safety: Electric shock hazards, leakage current, safety codes for electro medical equipments	1	
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 100% for theory.

Course code.	Course Name	L-T-P - Credits	Year of Introduction
EE482	ENERGY MANAGEMENT AND AUDITING	3-0-0-3	2016

Prerequisite: NIL

Course Objectives

- To enable the students to understand the concept of energy management
- To understand the different methods used to control peak demand
- To understand the energy management opportunities in different systems
- To understand how the use of energy audit.
- To understand the different methods used for the economic analysis of energy projects

Syllabus

General principles of Energy management and Energy management planning - Peak Demand controls - Energy management opportunities in electrical systems and HVAC systems – Reactive power management – Energy audit – cogeneration system – Economic analysis of energy projects

Expected outcome.

The students will be able to:

i. Understand the different methods used to reduce energy consumption
ii. Know energy audit
iii. Do economic analysis of energy projects

Text Book/Refernces:

1. Albert Thumann, William J. Younger, Handbook of Energy Audits, CRC Press, 2003
2. Charles M. Gottschalk , Industrial energy conservation, John Wiley &Sons, 1996.
3. Craig B. Smith, Kelly E Parmenter Energy management principles, Elsevier, 2ed, 2015 .
4. D. Yogi Goswami, Frank Kreith, Energy Management and Conservation Handbook , CRC Press,2007.
5. G.G. Rajan , Optimizing energy efficiencies in industry, Tata McGraw Hill, Pub. Co., 2001.
6. IEEE recommended practice for energy management in industrial and commercial facilities, IEEE std 739 - 1995 (Bronze book).
7. M Jayaraju and Premlet , Introduction to Energy Conservation And Management, Phasor Books, 2008.
8. Paul W O'Callaghan, Energy management, McGraw Hill Book Co., 1993
9. Wayne C.Turner, Energy management Hand Book, The Fairmount Press, Inc., 1997.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	General principles of Energy management and Energy management planning. Peak Demand controls, Methodologies, Types of Industrial Loads, Optimal Load scheduling-Case studies	6	15%
II	Energy management opportunities in Lighting and Motors. Electrolytic Process and Electric heating, Case studies	8	15%
FIRST INTERNAL EXAMINATION			

III	Types of boilers, Combustion in boilers, Performances evaluation, Feed water treatment, Blow down, Energy conservation opportunities in boiler. Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings. Classification, General fuel economy measures in furnaces, Excess air, Heat Distribution, Temperature control, Draft control, Waste heat recovery.	8	15%
IV	HVAC system: Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Classification and Advantages of Waste Heat Recovery system, analysis of waste heat recovery for Energy saving opportunities	7	15%
SECOND INTERNAL EXAMINATION			
V	Energy audit -Definition, Need, Types of energy audit, Energy audit Instruments. Cogeneration-Types and Schemes, Optimal operation of cogeneration plants- Case study. Computer aided energy management.	7	20%
VI	Economic analysis methods-cash flow model, time value of money, evaluation of proposals, pay-back method, average rate of return method, internal rate of return method, present value method, life cycle costing approach, Case studies.	6	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hrs.

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P -C	Year of Introduction
EE484	Control Systems	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- To give the knowledge of Mathematical model of physical systems.
- To impart knowledge of different control equipment.
- To provide knowhow of analysing systems with mathematical model.

Syllabus-

Linear Time Invariant systems: Open loop-and closed loop control systems, Transfer function: Mechanical, Electromechanical systems. block diagram representation, signal flow graph. Control system components. Time domain analysis of control systems. PID controllers, Concept of stability, Frequency domain analysis, Introduction to Statespace.

Expected outcome.

The students will have the

i. Concept of modelling in transfer function and state space domain
ii. Ability to analyse stability of linear time invariant systems.

Text Books:

1. Katsuhiko Ogata, "Modern Control Engineering", Fourth edition, Pearson Education, New Delhi, 2002.
2. Nagarath I.J. and Gopal M., "Control System Engineering", Wiley Eastern, New Delhi.
3. Richard C. Dorf, Robert. H. Bishop, "Modern Control Systems", Pearson Education, New Delhi – 11th Edition, 2007.

References:

1. Gibson & Tutter, "Control System Components", Mc Graw Hill.
2. Kuo B.C., "Automatic Control Systems", Prentice Hall of India, New Delhi, 6ed.,1991.
3. Norman S. Nise, "Control Systems Engineering", 5th Edition, Wiley Eastern, 2007.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Open loop-and closed loop control systems: Transfer function -T.F of simple linear time invariant systems - Mechanical andElectromechanical systems – Force voltage and force current analogy - block diagram representation - blockdiagram reduction - signal flow graph - Mason's gain formula - characteristics equation.	9	15%
II	Control system components: DC and AC servo motor – synchro - magnetic amplifier - gyroscope - stepper motor - Tacho meter.	5	15%
	FIRST INTERNAL EXAMINATION		
III	Time domain analysis of control systems: Transient and steady state responses - test signals - time domain specifications - first and second order systems - impulse and step responses - steady state error analysis - static error coefficient of type 0,1,2 systems - Dynamic error coefficients	7	15%
IV	PID controllers, Concept of stability: stability of feedback system - Routh's stability criterion - Root locus -General rules for constructing Root loci - effect of addition of poles and zeros.	7	15%
	SECOND INTERNAL EXAMINATION		
V	Frequency domain analysis: Introduction - Bode plot-Polar plot-	6	20%

	gain margin - phase margin.		
VI	Introduction to state space: State concept, state equation of simple systems, physical and phase variables, Eigen value and eigenvectors, conversion of state space model to transfer function.	8	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 **Exam Duration: 3Hrs.**

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P -C	Year of Introduction
EE486	SOFT COMPUTING	3-0-0-3	2016

Prerequisite: NIL

Course Objectives

- To provide the concepts of soft computing techniques such as neural networks, fuzzy systems, genetic algorithms

Syllabus

Introduction To Soft Computing And Neural Networks , Fuzzy Sets And Fuzzy Logic: Fuzzy Sets, Neuro-Fuzzy Modelling , Machine Learning, Machine Learning Approach to Knowledge Acquisition

Expected outcome.

The students will be able to get ideas on :

i. Artificial Intelligence, Various types of production systems, characteristics of production systems.
ii. Neural Networks, architecture, functions and various algorithms involved.
iii. Fuzzy Logic, Various fuzzy systems and their functions.
iv. Genetic algorithms, its applications and advances

Text Books:

1. James A. Freeman and David M. Skapura, "Neural Networks Algorithms, Applications, and Programming Techniques", Pearson Edn., 1991
2. Jyh-Shing Roger Jang, Chuen-Tsai Sun, EijiMizutani, "Neuro-Fuzzy and Soft Computing", Prentice-Hall of India, 2008
3. S.Y Kung , Digital Neural Network , Prentice-Hall of India, 1993

References:

1. Amit Konar, "Artificial Intelligence and Soft Computing", First Edition,CRC Press, 2000.
2. David E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Edn., 2006
3. George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic-Theory and Applications", Prentice Hall, 1995
4. Mitchell Melanie, "An Introduction to Genetic Algorithm", Prentice Hall, 1998
5. Simon Haykin, "Neural Networks: A Comprehensive Foundation", Prentice Hall

Course Plan

Module	Contents	Hours	End Sem .Exam Marks
I	Introduction To Soft Computing And Neural Networks : Evolution of Computing - Soft Computing Constituents – From Conventional AI to Computational Intelligence - Adaptive Networks – Feed forward Networks – Supervised Learning	7	15%
II	Neural Networks – Radial Basis Function Networks - Reinforcement Learning – Unsupervised Learning Neural Networks – Adaptive Resonance architectures. Fuzzy Sets And Fuzzy Logic: Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations - Fuzzy Rules and Fuzzy Reasoning	7	15%
FIRST INTERNAL EXAMINATION			

III	Fuzzy Inference Systems – Fuzzy Logic – Fuzzy Expert Systems – Fuzzy Decision Making Neuro-Fuzzy Modeling : Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Trees	7	15%
IV	Data Clustering Algorithms – Rulebase Structure Identification Neuro-Fuzzy Control.	7	15%
SECOND INTERNAL EXAMINATION			
V	Machine Learning : Machine Learning Techniques – Machine Learning Using Neural Nets – Genetic Algorithms (GA)	7	20%
VI	Applications of GA in Machine Learning - Machine Learning Approach to Knowledge Acquisition. Support Vector Machines for Learning – Linear Learning Machines – Support Vector Classification – Support Vector Regression - Applications.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hrs.

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P -C	Year of Introduction
EE488	INDUSTRIAL AUTOMATION	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- Explain the General function of Industrial Automation
- Identify Practical Programmable Logic Controller Applications
- Identify Types of Industrial Sensors
- Explain Robotics

Syllabus

Types of motion actuators, electrical and mechanical sensors, ladder diagrams, cascade method, Huffman method, Programmable Logic Controllers, Microcomputers: interfacing and programming, Principles of Robotics and applications

Expected outcome.

The students will be able to

i. Know about motion devices and various in automation
ii. Draw ladder diagrams for applications
iii. Understand assembly language programs
iv. Know about Robotic components

Text Book:

1. Pessen , Industrial Automation : Circuit Design and Components , Wiley

References:

1. Bartelt , Industrial Automated Systems, Instrumentation and Motion Control, , Cengage
2. Mukhopadyay et al , Industrial Instrumentation, Control and Automation, Jaico Publishing House

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Motion Actuators: Types of Motion and Motion Conversion, Electric Linear Actuators, Electric Rotary Actuators, Fluid-Power Linear Actuators, Fluid-Power Rotating Actuators	6	15%
II	Sensors: Binary vs. analog sensors, Electric Position sensors: Limit switches, photovoltaic sensors, ultrasonic sensors, inductive and capacitive and magnetic proximity sensors, Pneumatic position sensors: limit valves, back-pressure sensors, coiled spring sensors. Level, pressure, temperature and flow switches	6	15%
	FIRST INTERNAL EXAMINATION		
III	Electric Ladder Diagrams: Ladder diagrams, sequence charts, Ladder diagram design using sequence charts, cascade method,: single and multi path sequencing systems with and without sustained outputs, Huffman method: sequential systems, stable and unstable states, state assignment.	6	15%
IV	Programmable Controllers: PLC construction, Programming the PLC, constructing ladder diagrams for PLCs,	6	15%
	SECOND INTERNAL EXAMINATION		

V	Microcomputers :Microcomputers for control applications, architecture, computer interfacing, programmable interface adaptors, Ramping a step motor example.	8	20%
VI	Robotics and Numerical Control : Basic Robot Definitions, Basic manipulator configurations, Numerical Control Systems, Robot Kinematics, Robot Grippers, Robot Sensors, Robot Programming, General Considerations for Robot Applications	8	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3Hrs.

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P -C	Year of Introduction
EE494	Instrumentation Systems	3-0-0-3	2016

Prerequisite: NIL

Course Objectives

- To introduce the measurement techniques of force, torque, speed, pressure, flow & temperature.
- To introduce different types of electronic circuits for measurements and their applications.

Syllabus

General Concepts ,Generalised Configurations and Functional Description of Measuring Instruments, Measuring Devices, Force and Torque Measurements, Shaft Power Measurements, Pressure and Sound Measurements, Dynamic Testing of Pressure-Measuring Systems, Flow Measurement, Temperature Measurement, Bridge Circuits ,Amplifiers ,Filters, Integration and Differentiation, Voltage-Indicating and Recording Devices,Electromechanical Servo type XT and XY Recorders.

Expected outcome.

The students will be able to

i. Understand and analyze Instrumentation systems.

ii. Select proper measurement system for various applications.

Text Book:

1. Ernest O Doebelin and Dhanesh N Manik, Measurement Systems, Mc Graw Hill, 6e.

References:

1. Neubert H K P, Instrument Transducers, Oxford University Press, 1975
2. Turner and Hill, Instrumentation for Engineers and Scientists, Oxford University Press, 1999

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	General Concepts : Need for Measurement Systems, Classification of Types of Measurements Applications Generalised Configurations and Functional Description of Measuring Instruments : Functional Elements of an Instrument , Active and Passive Transducers , Analog and Digital Modes of Operation ,Null and Deflection Methods, Input-Output Configurations of Instruments and Measurement Systems	6	15%
II	Measuring Devices : Motion Measurements : Fundamental Standards, Relative Displacements: Translational and Rotational , Relative Velocity : Translational and Rotational, Relative - Acceleration Measurements Force and Torque Measurements : Standards and calibration , Basic Methods of Force Measurements , Characteristics of Elastic Force Transducers, Torque Measurement on Rotating Shafts	8	15%
FIRST INTERNAL EXAMINATION			
III	Shaft Power Measurements : Shaft Power Measurements (Dynamometers), Vibrating-Wire Force Transducers	8	15%

	Pressure and Sound Measurements: Standards and Calibration , Basic Methods of Pressure Measurements, Deadweight Gages and Manometers , Elastic Transducers, Vibrating-Cylinder and Other Resonant Transducers		
IV	Dynamic Testing of Pressure-Measuring Systems, High Pressure Measurement, Low Pressure(Vacuum) Measurement, Sound Measurements Flow Measurement :Local Flow Velocity , Magnitude and Direction , Gross Volume Flow Rate	6	15%
SECOND INTERNAL EXAMINATION			
V	Temperature Measurement : Standards and Calibration , Thermal-Expansion Methods ,Thermoelectric Sensors (Thermocouples),Electric-Resistance Sensors, Junction Semiconductor Sensors ,Digital Thermometers ,Radiation Methods	6	20%
VI	Bridge Circuits ,Amplifiers ,Filters, Integration and Differentiation Voltage-Indicating and Recording Devices : Standards and Calibration , AnalogVoltmeters and Potentiometers Electrical Instruments : RMS Voltmeter , Ohm Meter , Phase Meter , Q Meter Digital Voltmeters and Multimeters ,Signal GenerationSquare Wave Generation , Electromechanical Servo type XT and XY Recorders	8	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 **Exam Duration: 3Hrs.**

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P -Credits	Year of Introduction
FS482	RESPONSIBLE ENGINEERING	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To enable the students to create an awareness on responsibilities and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

Syllabus

Human Values - Engineering Ethics – Engineering as Social Experimentations – Engineer's responsibility for safety – Responsibilities and Rights – Global Issues.

Expected outcome.

- The students will be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society

Text Books:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

Data Book (Approved for use in the examination): Nil

References:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009
3. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, "Fundametals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001
5. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd.,New Delhi 2013.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	**HUMAN VALUES** Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.	8	15%
II	**ENGINEERING ETHICS** Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories	6	15%
FIRST INTERNAL EXAMINATION			

III	**ENGINEERING AS SOCIAL EXPERIMENTATION** Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.	7	15%
IV	**ENGINEER'S RESPONSIBILITY FOR SAFETY** Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk - Chernobyl Case Studies and Bhopal	7	15%
SECOND INTERNAL EXAMINATION			
V	**RESPONSIBILITIES AND RIGHTS** Collegiality and Loyalty – Respect for Authority - Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.	6	20%
VI	**GLOBAL ISSUES** Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.	6	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks: 100 Exam Duration: 3 hours

Part A – 8 questions (Module 1 to 4 one question each, Module 5 & 6 two questions each) of 2 marks each. All questions are compulsory (8x2 = 16)

Part B – 8 questions (Module 1 to 4 one question each, Module 5 & 6 two questions each) of 3 marks each. All questions are compulsory (8x3 = 24)

Part C – 12 questions (two questions from each module) of 10 marks each. Student has to answer one question from each module. (6x10=60**)**

Note: Each question can have a maximum of 4 sub parts, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
FT482	Food Process Engineering	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To introduce different thermal and non-thermal food processing principles.

Syllabus

Raw material Preparation, Blanching, Pasteurization, Sterilization, Size reduction, Drying, Psychrometry, Refrigeration, Baking, Frying, Extrusion, Sedimentation, Centrifugation, Minimal Processing, Packaging, Cleaning

Expected outcome.

- The students will gain knowledge on various food processes like pasteurization, drying, refrigeration, centrifugation etc.

Text Books:

1. *James G brennan , Food processing Handbook, Wiley – VCH, 2e.*
2. *P G Smith , Introduction to Food Process Engineering, Springer, 2e, 2011*
3. *Zeki Berk Food process engineering and technology, Elsevier, 2013*

References:

1. *Geankoplis, C.J. "Transport Processes and Separation Process Principles", 4th Edition, Prentice Hall, 2003.*
2. *McCabe W.L., Smith J.C. "Unit Operations in Chemical Engineering", 7th Edition, McGraw – Hill Int., 2001,*
3. *Richardson, J.E. etal., "Coulson & Richardson's Chemical Engineering" Vol.2 (Praticle Technology & Separation Processes") 5Th Edition, Butterworth – Heinemann / Elsevier, 2003.*

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Raw material Preparation and Thermal processing:** Food process, Raw material properties, physical, functional, preparation; Cleaning; wet and dry, Peeling methods, sorting and grading, Blanching, Pasteurization, HTST, LTLT, UHT, pasteurizers, microbial inactivation, F, D, Z values	7	15%
II	**Size Reduction:** Size reduction of solids, principles, laws of size reduction, kicks. Bond, rittinger, equipment; roller mill, impact mill, attrition mill, tumbling mills, methods, particle size distribution, energy consumption, homogenization	7	15%
	FIRST INTERNAL EXAMINATION		
III	**Drying and Psychrometry:** water activity, moisture content, drying rate curve,EMC, isotherms, Driers;Tray, tunnel,puff, fluidized bed, spray. Rotary drier etc. Freeze dryingDrying time prediction. Dehydrated productsRehydration	7	15%

	characterestics psychrometry, basic principles, psychrometric chart, terms, numerical solving		
IV	**Refrigeration:** Methods, equipment , VA, VC refrigeration systems, components; compressor, condenser, evaporator, refrigerant, COP Chilling and freezing , freezing kinetics-models, effect of low temperature on food spoilage, prediction of freezing time; Plank's,Pham's method, Thawing, Frozen food storage, freezer types. Refrigerated transportation; land, marine, air transportation Precooling methods	7	15%
SECOND INTERNAL EXAMINATION			
V	**Baking and Frying process** Baking Process, Frying process- principle, heat and mass transfer, machinery, products, frying oils, kinetics of oil uptake Extrusion, principle, extruded products Sedimentation and centrifugation; principle, basic equations, settling tank, baffled. Centrifugation, tubular, disc bowl,decanter, basket centrifuge.	7	20%
VI	**Minimal processing :** Ohmic heating, RF heating, Pulsed Electric field heating, High pressure processing, Food Irradiation, Ultrasound, Hurdle Technology Food filling and packaging systems, packaging materials, CAP, MAP, Vacuum.	7	20%
END SEMESTER EXAM			

Question paper pattern:

Maximum marks:100 **Exam Duration : 3 hours**

The question paper shall consist of three parts.

Part A : Three questions of 15 marks each uniformly covering modules 1 & 2. The students have to answer any two full questions. Each question can have maximum of 4 sub questions.

Part B : Three questions of 15 marks each uniformly covering modules 3 & 4. The students have to answer any two full questions. Each question can have maximum of 4 sub questions.

Part C : Three questions of 20 marks each uniformly covering modules 5 & 6. The students have to answer any two full questions. Each question can have maximum of 4 sub questions

Course code	Course Name	L-T-P - Credits	Year of Introduction
FT484	Food Storage Engineering	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- To introduce different storage mechanisms for food.

Syllabus

Traditional and modern storage structures, Silos, warehouses, cold storages, Storage of raw and processed foods, Supporting equipments; dryers, freezers etc.

Expected outcome.

Student will have knowledge on various food storage structures and mechanisms

Text Books:

1. *P G Smith , Introduction to Food Process Engineering, Springer, 2e, 2011*
2. *Zeki Berk, Food process engineering and technology, Elsevier, 2013*

References:

1. *Dennis R. Heldman, Richard W. Hartel , Principles of Food Processing, Aspen Publishers, Inc 1997*
2. *G. Boumans, Grain Handling and Storage, Volume 5 1st Edition, Elsevier Science, 1985*
3. *Himangshu Barman, Post Harvest Food Grain Storage, Agrobios (India), 2008*
4. *James G Brennan , Food processing Handbook, Wiley-VCH, 2e. 2006*

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Introduction:** Food and grain storage, introduction, scope, importance, basic requirements, safe and scientific storage. Selection of site for storage, pre and post storage operations; cleaning, drying, inspection etc., spoilage, control measures	7	15%
II	**Traditional and small scale storage:** Traditional storage methods, mud bin, drums, gunny bags etc., small scale storage structures, brick, concrete types, Local storage, morai, bhukari, kothar, kuthla structures, improved storage; bunker, cover and plinth, Factors affecting storage	7	15%
	FIRST INTERNAL EXAMINATION		
III	**Modern and large scale storage:** Bulk storage, warehouses; considerations, types. Silos; types- deep, shallow, Airys, Janseens equations, numericals	7	15%

IV	**Refrigerated storage:** Cold storage, refrigeration load calculations, cold storage components, vapour barriers,	7	15%
SECOND INTERNAL EXAMINATION			
V	**Storage of food** Frozen storage, CAS, MAS, hermetic storage, Storage conditions for raw and processed fruits, vegetables, meat, dairy etc. Storage requirements	7	20%
VI	**Supporting structure :** Supporting equipment; Drying before storing, dryers, humidifier, dehumidifier, freezers, conveyors for solid and liquid food storage. Aeration, ventilation Economic aspects of storage.	7	20%
END SEMESTER EXAM			

Question paper pattern:

Maximum marks:100 **Exam Duration : 3 hours**

The question paper shall consist of three parts.

Part A : Three questions of 15 marks each uniformly covering modules 1 & 2. The students have to answer any two full questions. Each question can have maximum of 4 sub questions.

Part B : Three questions of 15 marks each uniformly covering modules 3 & 4. The students have to answer any two full questions. Each question can have maximum of 4 sub questions.

Part C : Three questions of 20 marks each uniformly covering modules 5 & 6. The students have to answer any two full questions. Each question can have maximum of 4 sub questions

Course code	Course Name	L-T-P - Credits	Year of Introduction
FT486	Food Additives and Flavourings	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To know the role and activity of chemical and natural food additives.

Syllabus

Food additives and their permissible limits, Additives used for colouring preservation, Antioxidants, Additives for emulsification, stabilization, Acidulants sweeteners, Flavouring agents, Sensory valuation

Expected outcome.

- The students will get knowledge of food additives and their permissible limits

Text Books:

1. *Branen, Davidson, Salmines , Food Additives, , 2nd edition Marecl Delker Publishers, 2002*
2. *Fennema,, Food Chemistry, 4th edition CRC Press, 1996*

References:

1. *Alexander, R.J.. Sweeteners: Nutritive. St. Paul, MN: Eagan Press. 1998*
2. *Cremer, M.L. Quality Food in Quantity. Management and science. Berkely C.A: McCutchan Publishing Company, 1998.*
3. *Ensminger, AH., ME. Ensminger, J.E. Konlande and J.R. Robson, Foods and Nutrition Encyclopaedia 2 Vols. Clovis, C.A: Pegus Press, 1983.*
4. *Francis F.J. Colorants. St. Paul,MN: Eagan Press, 1998,*
5. *Pruthi, J.S , Spices & Condiments, National Book Trust of India, 2014.*
6. *Reinecius , Flavour chemistry and technology, 2nd edition Taylor & Francis, 2006.*
7. *Stauffer C.E.. Emulsifiers. St. Paul, MN.: Eagan Press., 1999*
8. *Thomas O.J. and WA Atwell. Starches. St. Paul,MN.: Eagan Press, 1999*

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	**Introduction:** Food Additives- definition, intentional and incidental additives, evaluation of additives, maximum permissible limit, methods for finding tolerance limits, approval of food additive, Risk assessment, levels of toxicity, acute and chronic studies, government regulations with respect to additives	6	15%

II	**Additives used in food preservation and processing** Additives used in food preservation and processing preservative, antioxidants, colouring agents: functions, chemistry, mode of action ,uses in food formulations	7	15%
FIRST INTERNAL EXAMINATION			
III	**Emulsifiers, Stabilizers:** Emulsifiers, Stabilizers, Ant caking agents, Enzymes, Gases,: Function and Applications, mode of action, chemistry, physical and chemical properties, permissible level in foods	7	15%
IV	**Acidulants, Sweeteners:** Acidulants, Sequestrants, , Sweeteners ,Nutritive additives: Function and Applications, Safety issues, mode of action, chemistry, physical and chemical properties, permissible level in foods	7	15%
SECOND INTERNAL EXAMINATION			
V	**Sensory instruments** Food Flavour, its importance ,substances responsible for flavour, flavour isolation methods, essential oil, oleoresins, spray dried products, different flavour products, extracts, essences, flavour emulsions, flavour analysis(GC, Electronic Nose), scoville unit	8	20%
VI	**Flavouring agents** Flavouring agents used in food industry, natural, natural identical and artificial flavouring agents, process flavour, flavour enhancer/modifier, commonly used flavouring agents in food	7	20%
END SEMESTER EXAM			

Question paper pattern:

Maximum marks:100 **Exam Duration : 3 hours**

The question paper shall consist of three parts.

Part A : Three questions of 15 marks each uniformly covering modules 1 & 2. The students have to answer any two full questions. Each question can have maximum of 4 sub questions.

Part B : Three questions of 15 marks each uniformly covering modules 3 & 4. The students have to answer any two full questions. Each question can have maximum of 4 sub questions.

Part C : Three questions of 20 marks each uniformly covering modules 5 & 6. The students have to answer any two full questions. Each question can have maximum of 4 sub questions

Course code	Course Name	L-T-P-C	Year of Introduction
IC482	BIOMEDICAL SIGNAL PROCESSING	3-0-0-3	2016

Prerequisite: NIL

Course Objectives

- To study various biomedical signals and their data reduction
- To learn frequency domain and time series analysis of biomedical signals
- To study spectral estimation of biomedical signals
- To study event detection and waveform analysis

Syllabus

Introduction to biomedical signals- ECG analysis – Data reduction – Signal averaging- Frequency domain analysis-Time series analysis- Spectral analysis- Event detection and waveform analysis.

Expected Outcome

The students will be able to

- Visualise difficulties involved in biomedical signal processing
- Do time series and frequency domain analysis of biomedical signals
- Conduct spectral estimation of biomedical signals
- Perform event detection and waveform analysis of biomedical signals

References

1. Arnon Cohen, Biomedical Signal Processing Time and Frequency Domains Analysis (Volume I), CRC press.
2. D.C.Reddy, Biomedical Signal Processing Principles and Techniques, Tata Mc Graw-Hill
3. Rangaraj M Rangayyan, Biomedical Signal Analysis A case study approach, John Wiley publications.
4. Willis J. Tompkins, Biomedical Digital Signal Processing, PHI.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	**Introduction:** Introduction to biomedical signals, Biomedical signal acquisition and processing, Difficulties in signal acquisition	4	**15%**
II	**ECG:** ECG signal origin, ECG parameters-QRS detection different techniques, ST segment analysis, Arrhythmia, Arrhythmia analysis, Arrhythmia monitoring system.	6	**15%**
	FIRST INTERNAL EXAM		
III	**ECG Data Reduction:** Direct data compression Techniques: Turning Point, AZTEC, Cortes, FAN, Transformation Compression Techniques: Karhunen - Loeve Transform, Other	8	**15%**

	data compression Techniques: DPCM, Huffman coding, Data compression Techniques comparison. **Signal averaging:** Basics of signal averaging, Signal averaging as a digital filter, A typical averager, Software and limitations of signal averaging.		
IV	**Frequency Domain Analysis**: Introduction, Spectral analysis, linear filtering, cepstral analysis and homomorphic filtering. Removal of high frequency noise (power line interference), motion artifacts (low frequency) and power line interference in ECG,	8	**15%**
SECOND INTERNAL EXAM			
V	**Time Series Analysis:** Introduction, AR models, Estimation of AR parameters by method of least squares and Durbin's algorithm, ARMA models. Spectral modelling and analysis of PCG signals. **Spectral Estimation:** Introduction, Blackman- tukey method, The periodogram, Pisarenko's Harmonic decomposition, Prony' method, Evaluation of prosthetic heart valves using PSD techniques. Comparison of the PSD estimation methods.	9	**20%**
VI	**Event Detection and waveform analysis:** Need for event detection, Detection of events & waves, Correlation analysis of EEG signals, The matched filter, Detection of the P wave , Identification of heart sounds, Morphological analysis of ECG waves, analysis of activity.	7	**20%**
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

Part A

Answer any two out of three questions from Module 1 and 2 together. Each question carries 15 marks and can have not more than four sub divisions. (15 x 2 = 30 marks)

Part B

Answer any two out of three questions from Module 3 and 4 together. Each question carries 15 marks and can have not more than four sub divisions. (15 x 2 = 30 marks)

Part C

Answer any two out of three questions from Module 5 and 6 together. Each question carries 20 marks and can have not more than four sub divisions. (20 x 2 = 40 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
IE482	FINANCIAL MANAGEMENT	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To build an understanding of concepts, vital tools and techniques applicable for financial decision-making by a business firm.
- To understand the use of basic financial management concepts.
- To become familiar with the various types of financing available to a firm.

Syllabus:

Nature and Scope of Financial Management; Time Value of Money, Cash Flow Statement and its Interpretation, Financial Statement Analysis, Sources of Finance, Capital Structure; Dividend Decision; Fixed and Current, Short-term financial planning, working capital–planning and management, Capital Budgeting.

Expected outcome.

The students will be able to

i. Obtain an overview of financial system.
ii. Analyze financial statements using standard financial ratios.
iii. Apply techniques to project financial statements for forecasting long-term financial needs.
iv. Understand the role of short-term financial needs.
v. Apply time value, risk, and return concepts.

Text books

1. Khan, M. Y. and Jain P. K., Financial Management, Text, Problems & Cases, Tata McGraw Hill Company, New Delhi, 2007.
2. Pandey I. M., Financial Management, Vikas Publishing House Pvt. Ltd., 2009.
3. Prasanna Chandra, Financial Management: Theory and Practice, Tata McGraw Hill, 2011

References:

1. Bhalla. V. K., Financial Management and Policy: Text and Cases, 9th Edition, Anmol Publications Pvt. Ltd, 2009.
2. Brigham. Eugene F. and Houston. Joel F., Fundamentals of Financial Management, 10th Edition, Cengage Learning, 2006.
3. Gitman, L. J., Principles of Managerial Finance, New York, 2006.
4. Sheeba Kapil, Financial Management, Pearson Education, 2010.
5. Van Horne and C. James, Principles of Financial Management, Pearson, 2002.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Nature and Scope of Financial Management; Financial Objectives; goal of financial management, FM decisions, Time Value of Money.	7	15%
II	Funds Flow Analysis; Cash Flow Statement and its Interpretation, Financial Statement Analysis, Ratio Analysis, Time Series.	7	15%
FIRST INTERNAL EXAMINATION			

III	Planning for Sources of Finance; Capital Structure; Net Income Approach; Net Operating Income Approach; Traditional Approach and MM Approach, Cost of Capital; EBIT – EPS Analysis, Capital Gearing/Debt-Equity Ratio	7	15%
IV	Retained Earning Vs. Dividend Decision; Gordon Model; Walter Model; MM Approach; Fixed and Current, Short-term financial planning.	7	15%
SECOND INTERNAL EXAMINATION			
V	Working capital–Gross and net working capital, planning and management, Operating Cycle, Determination of working capital.	7	20%
VI	Capital Budgeting – Evaluation techniques for capital budgeting, capital budgeting decision criteria, NPV–IRR comparisons, capital rationing.	7	20%
END SEMESTER EXAM			

End Semester Examination Question Paper Pattern:

Examination duration: 3 hours Maximum Marks: 100

Part A (Modules I and II):

Candidates have to answer any 2 questions from a choice of 3 questions. Each full question carries a total of 15 marks and can have a maximum of 4 sub questions (a, b, c, d). No two full questions shall be exclusively from a single module. All three questions shall preferably have components from both modules. Marks for each question/sub question shall be clearly specified. Total percentage of marks for the two modules put together as specified in the curriculum shall be adhered to for all combinations of any two questions.

Part B (Modules III and IV): (Same as for part A marks)

Part C (Modules V and VI):

(Same as for part A, except that each full question carries 20 marks)

Note: If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.

Course code	Course Name	L-T-P - Credits	Year of Introduction
IE484	INTRODUCTION TO BUSINESS ANALYTICS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To knowhow the use of business analytics to formulate and solve business problems and to support managerial decision making.
- To familiarize the practices needed to develop, report, and analyze business data.

Syllabus:

Descriptive Analytics - Visualizing and Exploring Data, Descriptive Statistical Measures, Probability Distributions and Data Modeling, Sampling and Estimation, Statistical Inference

Predictive Analytics - Trend lines and Regression Analysis, Forecasting Techniques, Introduction to Data Mining, Monte Carlo Simulation and Risk Analysis

Prescriptive Analytics - Linear Programming Problem-Formulation, Solution methods; Transportation Problem-Formulation and solution; Assignment Problem- Formulation and solution; Dynamic Programming problem; Integer Programming Problem- Formulation and solution.

Expected outcome:

The students will:

i. gain the knowledge of fundamental concepts and tools needed to understand the emerging role of business analytics in organizations.

ii. be able to apply basic business analytics tools, interpret analytic models and results for making better business decisions.

References:

1. James R. Evans, Business Analytics, Pearson Education Limited, 2017
2. Amir D. Aczel and J. Sounderpandian, Complete Business Statistics, Tata McGraw Hill, 2006
3. Wayne L. Winston, Operations Research: Applications and Algorithms, PWS-Kent Pub.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Business Analytics-Evolution, Scope, Models **Descriptive Analytics**- Data Visualization, Statistical Methods for Summarizing Data, Measures of Central Tendency, Measures of Dispersion, Measures of Shape, Measures of Association, Probability Distributions and Data Modeling- Discrete and Continuous Probability Distributions, Random Sampling from Probability Distributions, Data Modeling and Distribution Fitting	7	15%
II	Sampling and Estimation - Statistical Sampling, Estimating Population Parameters, Sampling Distributions, Confidence Intervals, Prediction Intervals Statistical Inference- Hypothesis Testing, Confidence Intervals, One sample and Two sample tests, z-test, t-test, Chi-square test. Analysis of Variance: Theory and computations of ANOVA, ANOVA table, Two-way ANOVA, Blocking designs, Design of Experiments	7	15%
FIRST INTERNAL EXAMINATION			

III	**Predictive Analytics**- Modeling Relationships and Trends in Data, Simple Regression and Correlation: Introduction, Estimation using the regression line, Correlation Analysis. Multiple Regression: The k-variable multiple regression model, The F-test of a Multiple Regression model.	7	15%
IV	Forecasting Techniques- Qualitative and Judgmental Forecasting, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality Introduction to Data Mining, Monte Carlo Simulation and Risk Analysis	7	15%
SECOND INTERNAL EXAMINATION			
V	**Prescriptive Analytics** - Linear Programming Problem- Formulation, Graphical solutions, Simplex method, Revised Simplex method and Sensitivity Analysis; Transportation Problem- Formulation and solution; Assignment Problem- Formulation and solution	7	20%
VI	Deterministic Dynamic Programming problem Bellman's principle of optimality - computational procedure for Shortest Route problem, Reliability Problem, Equipment Replacement Problem etc; Integer Programming Problem- Formulation, Branch and Bound algorithm, Cutting Plane Algorithm	7	20%
END SEMESTER EXAM			

End Semester Examination Question Paper Pattern:

Examination duration: 3 hours Maximum Marks: 100

Part A (Modules I and II):

Candidates have to answer any 2 questions from a choice of 3 questions. Each full question carries a total of 15 marks and can have a maximum of 4 sub questions (a, b, c, d). No two full questions shall be exclusively from a single module. All three questions shall preferably have components from both modules. Marks for each question/sub question shall be clearly specified. Total percentage of marks for the two modules put together as specified in the curriculum shall be adhered to for all combinations of any two questions.

Part B (Modules III and IV): (Same as for part A marks)

Part C (Modules V and VI): (Same as for part A, except that each full question carries 20 marks)

Note: If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.

Course code	Course Name	L-T-P - Credits	Year of Introduction
IE486	DESIGN AND ANALYSIS OF EXPERIMENTS	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To introduce the concept of experimentation
- To equip students to understand the necessity of experimentation
- To provide basic methods of designing an experiment

Syllabus:

Statistical fundamentals, hypothesis testing, analysis of variance, block design, statistical analysis of models, full factorial and fractional factorial designs, introduction to Taguchi method.

Expected outcome .

The students will be able to:

- Understand the need for a design for experimentation
- Apply the basic principles to do an experiment design
- Make inferences out of the outcomes of experimental design.

References:

1. Montgomery, D.C., Design and Analysis of experiments, 8the Ed, John Wiley and Sons, 2013.
2. Montgomery, D.C., Statistical Quality Control, 6th Ed., John Wiley & Sons, Inc. 2009
3. Nicolo Belavendram, Quality by Design; Taguchi techniques for industrial experimentation, Prentice Hall, 1995.
4. Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996.
5. Phadke, Quality Engineering Using Robust Design, Pearson Education Singapore Pte Ltd; First edition, 2008

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Basic Statistical Concepts, sampling and sampling distributions, comparisons of populations by sample statistics – known populations parameters and unknown population parameters, paired comparisons	7	15%
II	Importance of experiments, experimental strategies, basic principles of design, terminology, steps in experimentation, sample size, normal probability plot, linear regression model.	7	15%
	FIRST INTERNAL EXAMINATION		
III	Hypothesis testing – z-test, t-test, chi-square test and F-test, Single factor experiments – ANOVA, model adequacy testing	7	15%
IV	Completely randomized design, Randomized block design, Latin square design. Statistical analysis, estimation of model parameters, model adequacy testing and interpretation of results	7	15%
	SECOND INTERNAL EXAMINATION		
V	Two and three factor full factorial experiments, 2^K factorial Experiments, confounding and Blocking designs.	7	20%
VI	Fractional factorial designs, Introduction to Response Surface Methodology, theory of experiments with random factors,	7	20%

	introduction to Taguchi design method. Use of software packages in design of experiments.		
END SEMESTER EXAM			

Question Paper Pattern:

Examination duration: 3 hours Maximum Marks: 100

Part A (Modules I and II):

Candidates have to answer any 2 questions from a choice of 3 questions. Each full question carries a total of 15 marks and can have a maximum of 4 sub questions (a, b, c, d). No two full questions shall be exclusively from a single module. All three questions shall preferably have components from both modules. Marks for each question/sub question shall be clearly specified. Total percentage of marks for the two modules put together as specified in the curriculum shall be adhered to for all combinations of any two questions.

Part B (Modules III and IV): (Same as for part A marks)

Part C (Modules V and VI):

(Same as for part A, except that each full question carries 20 marks)

Note: If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.

Course code	Course Name	L-T-P - Credits	Year of Introduction
IE488	TOTAL QUALITY MANAGEMENT	3-0-0-3	2016

Prerequisite : Nil

Course Objectives:

- To impart knowledge on principles and practices of TQM to achieve quality.
- To enable use of TQM tools for continuous quality improvement.
- To provide ideas on implementation of quality standards.
- To introduce the latest TQM tools and techniques.

Syllabus:

Introduction to quality, Contributions of quality Gurus, Quality control tools, Cost of Quality, Taguchi loss function, Basic concepts of TQM, Principles of Total Quality Management, Total quality control, Quality assurance, Vendor rating, Quality improvement programmes, Quality planning, Quality function deployment, Six sigma approach, Failure mode & effect analysis, TPM, BPR , Quality standards.

Expected outcome.

The students will be able to

i. Understand the principles and practices of TQM.
ii. Use various TQM tools for continuous quality improvement.
iii. Implement quality standards.
iv. Become aware of the latest TQM tools and techniques.

References:

1. Sharma D D, *Total Quality Management*, Sultan Chand & Sons, 2014
2. R.P. Mohanty & R R Lakhi, *Total Quality Management*, Jaico Pub, New Delhi, 1994
3. Poornima M.Charantimath , *Total Quality Management*, Pearson Education, 2011.
4. Lon Roberts , *Process Re-Engineering* , Tata McGraw Hill, New Delhi, 1994
5. Mohamed Zairi , *TQM for Engineers* , Gulf Pub. Co., 2nd Edition, New Delhi.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction-Need for quality, Definition of quality, Major contributions of Deming, Juran and Crossby to Quality Management, Quality control tools, Cost of Quality, Taguchi loss function.	7	15%
II	Basic concepts of Total Quality Management - Evolution of TQM, TQM framework, Barriers to TQM, Principles of Total Quality Management- Quality statements, Customer focus, Customer orientation,	7	15%

	Customer satisfaction, Customer complaints, Customer retention, Total quality control, total waste elimination, total employee involvement.		
FIRST INTERNAL EXAMINATION			
III	Quality assurance- Total quality assurance, Management principles in quality assurance, Objectives of quality assurance system, Hierarchical planning for Quality Assurance, Vendor rating, Quality improvement: elements, programmes – KAIZEN, PDCA cycle,5S, Quality circles.	7	15%
IV	Quality planning- SWOT analysis, Strategic planning, strategic grid, organizational culture, Total Quality Culture, Quality function deployment- QFD concept, the voice of customer, developing a QFD matrix, QFD process.	7	15%
SECOND INTERNAL EXAMINATION			
V	Six sigma approach–Methodology, Training, application to various industrial situations, Failure mode & effect analysis- Concepts, Types & Applications in TQM.	7	20%
VI	TPM–Concepts, Improvement needs, Performance measures, BPR, Quality standards – Need of standardization, ISO 9000 series, ISO 14000 series, Other contemporary standards.	7	20%
END SEMESTER EXAM			

Question Paper Pattern:

Examination duration: 3 hours Maximum Marks: 100

Part A (Modules I and II):
Candidates have to answer any 2 questions from a choice of 3 questions. Each full question carries a total of 15 marks and can have a maximum of 4 sub questions (a, b, c, d). No two full questions shall be exclusively from a single module. All three questions shall preferably have components from both modules. Marks for each question/sub question shall be clearly specified. Total percentage of marks for the two modules put together as specified in the curriculum shall be adhered to for all combinations of any two questions.

Part B (Modules III and IV): (Same as for part A marks)

Part C (Modules V and VI): (Same as for part A, except that each full question carries 20 marks)

Note: If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.

Course code.	Course Name	L-T-P -C	Year of Introduction
IT482	Information Storage Management	3-0-0-3	2016

Prerequisite: NIL

Course Objectives

- To understand data creation and the amount of data being created
- To impart the value of data to a business, challenges in data storage and data management,
- To introduce solutions available for data storage, Core elements of a data center infrastructure, role of each element in supporting business activities

Syllabus

Storage system architecture, Networked storage, Information availability and monitoring a data center, remote data replication technologies, securing storage and storage virtualization,

Expected outcome.

The students will understand the concept of data storage in distributed environment in data center, challenges in data storage and management technologies.

Text Books:

1. Robert Spalding, "Storage Networks: The Complete Reference", Tata McGraw Hill, New Delhi, 2006.
2. Somasundaram G, Alok Shrivastava, "ISM – Storing, Managing and Protecting Digital Information", EMC Education Services, Wiley India, New Delhi, 2012.

References:

1. Gerald J Kowalski, Mark T Maybury, "Information Storage and Retrieval Systems: Theory and Implementation", BS Publications, New Delhi, 2009.
2. Marc Farley Osborne, "Building Storage Networks", Tata McGraw Hill, New Delhi, 2001.
3. Meeta Gupta, "Storage Area Network Fundamentals", Pearson Education, New Delhi, 2002.

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Data, Information, Evolution of storage architecture, Data center infrastructure, Information lifecycle. Overview: Virtualization - Cloud, Data center environment: Application - Desktop - Memory virtualization - Connectivity - Disk drive interface	7	15%
II	Storage media - Flash drives, RAID: Implementation - Methods - Levels, Intelligent storage system	5	15%
	FIRST INTERNAL EXAMINATION		
III	Introduction to DAS and SCSI, SAN: Evolution - Components - Connectivity options - Ports - FC architecture - Zoning - FC topologies, SAN based virtualization: Block level - VSAN, IP SAN: iSCSI - FCIP components - FCIP topology and frame structure, FCOE: Components – Benefits	7	15%
IV	NAS: Benefits – Components - Implementations - File sharing	7	15%

	protocols - I/O operations - Factors affecting NAS performance - File level virtualization, Object based storage: Operation Benefits - Fixed content and archives - Archive types, CAS: Architecture - Operations - Use cases, Unified storage		
SECOND INTERNAL EXAMINATION			
V	Introduction: Information availability - BC terminology - Planning lifecycle - Business impact analysis - Technology solutions, Backup and restore: Purposes - Methods - Architecture - Operations - SCB - Topologies - Targets - Deduplication, Local Replication: Terminology - Data consistency - Technologies - Restore and restart considerations, Remote replication: Modes - Technologies - Advanced replication technologies	8	20%
VI	Securing the storage infrastructure: Security terminology - Security framework – Risk triad - Security domains -Implementations - Managing the storage infrastructure: Monitoring - Activities - Challenges - Solutions Data Warehousing with Oracle BI	8	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks: 100 Exam Duration: 3 hours

The question paper shall consist of Part A, Part B and Part C.

Part A shall consist of three questions of 15 marks each uniformly covering Modules I and II. The student has to answer any two questions (15×2=30 marks).

Part B shall consist of three questions of 15 marks each uniformly covering Modules III and IV. The student has to answer any two questions (15×2=30 marks).

Part C shall consist of three questions of 20 marks each uniformly covering Modules V and VI. The student has to answer any two questions (20×2=40 marks).

Note : Each question can have a maximum of 4 subparts, if needed

Course code	Course Name	L-T-P - Credits	Year of Introduction
MA482	APPLIED LINEAR ALGEBRA	3-0-0-3	2016

Prerequisite: NIL

Course Objectives

1. To visualize of vectors in n-space which is useful in representing data.
2. To learn handling of linear system of equations using matrix as a tool.
3. To introduce eigen values and eigen vectors which are significant in dynamic problems.
4. To introduce matrix decompositions methods that reduce a matrix into constituent parts which make it easier to calculate more complex matrix operations

Syllabus:

Vector spaces, linear equations and matrices, linear transformation, Inner product, eigen values and eigen vectors, matrix decomposition.

Expected outcome:

The students will be able to apply

1. Theory of vector space in representing data.
2. Matrix operations in solving system of linear equations.
3. Matrix decomposition in solving system of equations.

Text Books:

1. Gilbert Strang Linear Algebra and It's Applications, 4th edition, Cengage Learning, 2006.
2. Stephen Boyd, Lieven Vandenberghe, Introduction to Applied Linear Algebra: Vectors, Matrices, and Least Squares, Cambridge University Press, 2018
3. W. Keith Nicholson, Linear Algebra with applications, 4th edition, McGraw-Hill, 2002

References:

1. I.N Herstein, Topics in Linear Algebra, Wiley Eastern, 1975.
2. S.Kumaresan, Linear Algebra : A Geometric Approach, Prentice-Hall of India, 2000.
3. Seymour Lipschutz, Marc Lipson, Schaum's outline of linear algebra, 3rd Ed., Mc Graw Hill Edn., 2017

Module	Content	Hours	End Sem. Exam Marks %
I	**Vector Spaces:** Vector Spaces, Subspaces- Definition and Examples, Linear independence of vectors, Bases and dimension, Linear Span, Field-Definition	6	15%
II	**Vector space in R^n:** System of linear equations, row space, Column space and null space. Four fundamental spaces, relation between rank and nullity, consistency theorem, basis from a spanning set and independent set:	7	15%
	FIRST INTERNAL EXAMINATION		
III	**Linear transformations**: General linear transformation, Matrix of transformation, Kernel and range, properties, Isomorphism, change of basis, invariant subspace, Linear functional.	7	15%
IV	**Inner Product:** Real and complex inner product spaces, properties of inner product, length and distance, Cauchy-Schwarz inequality, Orthogonality, Orthogonal complement, Orthonormal bases, Gram Schmidt orthogonalization	8	15%
	SECOND INTERNAL EXAMINATION		

V	**Eigens pace:** Properties of Eigen values and Eigen vectors , Eigen values, Eigen vectors, minimal polynomial, Diagonalization, Orthogonal diagonalization, Jordan canonical form	8	20%
VI	**Matrix Factorization:** LU decomposition, QR Decomposition and singular value decomposition	6	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN
(End semester examination)

Time: 3 hours **Maximum marks: 100**

The question paper shall consist of Part A, Part B and Part C.

Part A shall consist of three questions of 15 marks each uniformly covering Modules I and II. The student has to answer any two questions (15×2=30 marks).

Part B shall consist of three questions of 15 marks each uniformly covering Modules III and IV. The student has to answer any two questions (15×2=30 marks).

Part C shall consist of three questions of 20 marks each uniformly covering Modules V and VI. The student has to answer any two questions (20×2=40 marks)

Course code	Course Name	L-T-P -Credits	Year of Introduction
MA484	OPERATIONS RESEARCH	3-0-0-3	2016

Prerequisite: NIL

Course Objectives:

1. To understand the fundamentals of Operation Research
2. To acquire the knowledge in different Operation Research techniques

Syllabus: Linear programming problem-Basic feasible solutions- Degeneracy dual Linear programming problems. Optimality conditions-The Simplex Method. Artificial Variables-Charnes'M method-Two phase Method. Dual of Linear programming problems- Duality principle, The Primal-Duality solutions using Simplex Method. Revised Simplex method. Assignment Problem-Formation-Optimal Solution-Hungarian Assignment Method-Traveling salesman problem-sequencing problem-Basic terms used in sequencing-Processing n Jobs through Two Machines-Processing n Jobs through k machines-Processing 2 Jobs through k Machines. Project management: Guidelines for network construction. Critical path method. (CPM). Project evaluation and review technique.(PERT). Network Techniques: Shortest path problem. (Dijkstras Algorithm). Maximum flow problem. Minimum spanning tree problem. Prim algorithm. The Recursive Equation approach- Characteristics of Dynamic programming-Dynamic programming Algorithm-Solution of Discrete D.P.P-Some applications-Solution of L.P.P by Dynamic Programming

Expected Outcome

Students will be able to

1. Solve different type LPP
2. Apply the concept of O.R in real life problems
3. Understand how to translate a real-world problem, given in words, into a mathematical formulation
4. Understand design and analysis of algorithms in network techniques and project management.

Text Books:

1. G Hadley, Linear programming, Narosa Publishing House, New Delhi, 2002
2. Kanti Swarup, P.K.Guptha, Man Mohan, Operations Research, Sultan Chand & Sons, New Delhi, 2010.
3. Taha.H.A, OperationResearch, Pecarson, 2004

References:

1. Francis & White, Facility Layout & Location, Prentice Hall Inc., 1974
2. Hillier & Lieberman, Introduction to Operations Research, Holden Day Inc., 1996
3. R Panneerselvam, Operation Research. PHI, 2006
4. Samuel Eilon, Elements of Production Planning & Control, Universal Book, 1991. Corporation

Module	Syllabus	Hours	End Sem. Exam Marks
I	Linear programming problem-Basic feasible solutions-Degeneracy dual Linear programming problems. Optimality conditions-The Simplex Method. Artificial Variables- Charnes'M method-Two phase Method.	7	**15%**
II	Dual of Linear programming problems- Duality principle, The Primal-Duality solutions using Simplex Method. Revised Simplex method	7	15%

FIRST INTERNAL EXAMINATION			
III	Transportation problem - Formulation - Existence of solutions of Transportation problems - Solutions of Transportation problem - finding an initial basic solution - North west corner method - Least cost Method - Vogel's Approximation Method - Test for optimality - Modi. Method - Unbalanced transportation problem in Transportation Problems – Transhipment model – Problem with sources and destination acting as transient nodes.	7	15%
IV	Assignment Problem-Formation-Optimal Solution-Hungarian Assignment Method-Travelling salesman problem-sequencing problem-Basic terms used in sequencing-Processing n Jobs through Two Machines-Processing n Jobs through k machines-Processing 2 Jobs through k Machines.	7	15%
SECOND INTERNAL EXAMINATION			
V	Project management: Guidelines for network construction, Critical path method (CPM), Project evaluation and review technique (PERT), Network Techniques: Shortest path problem, Dijkstras Algorithm, Maximum flow problem, Minimum spanning tree problem, Prim algorithm.	7	20%
VI	The Recursive Equation approach- Characteristics of Dynamic programming-Dynamic programming Algorithm-Solution of Discrete D.P.P-Some applications-Solution of L.P.P by Dynamic Programming	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN
(End Semester Examination)

Time: 3 hours **Maximum marks: 100**

The question paper shall consist of Part A, Part B and Part C.

Part A shall consist of three questions of 15 marks each uniformly covering Modules I and II. The student has to answer any two questions (15×2=30 marks).

Part B shall consist of three questions of 15 marks each uniformly covering Modules III and IV. The student has to answer any two questions (15×2=30 marks).

Part C shall consist of three questions of 20 marks each uniformly covering Modules V and VI. The student has to answer any two questions (20×2=40 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MA486	ADVANCED NUMERICAL COMPUTATIONS	3-0-0-3	2016

Prerequisite: NIL

Course Objectives.

1. To understand the role of approximation theory in engineering problems.
2. To familiarize various numerical methods for computation.
3. To understand the role of optimization in problem solving.

Syllabus:

Matrix Computations, Interpolation and approximation, Inner product and Norms, Nonlinear programming, Numerical Solution of Partial differential equations

Expected outcome

At the end of the course the student will be able to

(i) solve the linear system of equations
(ii) find the interpolation and approximations
(iii) apply various optimization methods in non linar programming
(iv) analyse the solution by finding the numerical solution of partial differential equations

Text Books:

1. B S Grewal, Numerical methods in Engineering and Science, Khanna Publishers
2. Sastry S.S., Introductory Methods of Numerical Analysis ,Fifth Edition, PHI, 2012
3. Singiresu .S. Rao, Engineering Optimization: Theory and Practice, 3rd edition,New age international publishers.

References:

1. David K. Ruch and Patrick J. Fleet, Wavelet Theory, An Elementary Approach With Applications, John Wiley, 2009
2. Howard Anton and Chris Rorres, Elementary Linear Algebra, 11th Edition, Wiley India, 2014
3. P. Kandasamy and K Thilagavathi: Numerical methods: S CHAND Publishers.
4. Stephen Andrilli and David Hecker, Elementary Linear Algebra, 4th edition, Academic Press,2010
5. Stevwn C. Chapra and Raymond R. Canale, Numerical methods for engineer, Seventh Edition, McGraw-Hill, 2015.

Module	Syllabus	Hours	End Sem. Exam Marks
I	**Matrix Computations:** Solving linear system: Factorization method, Relaxation method. Singular value decomposition, Matrix Eigen Value problem, Power method, Jacobi's method.	7	15%
II	**Inner product and Norms**: Inner product spaces, properties of inner product, length, distance and norms, Matrix norms, Cauchy–Schwarz inequality, Orthogonality, Gram-Schmidt Process, Orthogonal projection.	7	15%
	FIRST INTERNAL EXAMINATION		
III	**Interpolation:** Finite difference operators, interpolation using divided difference. Numerical differentiation: derivatives from difference table (finite difference and divided difference). Evaluation of double integrals Trapezoidal and Simpsons rule.	7	15%

IV	**Nonlinear programming:** One dimensional minimization methods. Unimodal functions. Elimination methods: Unrestricted search method, Fibonacci method, Golden section methods. Interpolation methods: Quadratic interpolation method. Direct root method: Newton method.	7	15%
SECOND INTERNAL EXAMINATION			
V	**Nonlinear programming (Contd.)**: Unconstrained optimization techniques: Direct search method: random search methods, Grid search method, Univariate method. Indirect search methods: Conjugate gradient method(Fletcher –Reeves method), Newton's method, Marquardt method	7	20%
VI	**Numerical Solution of PDE:** Finite difference approximation of partial derivatives, classification of second order P.D.E. Solution of Elliptic equation-Laplace equation. and Poisson equation. Solution of parabolic equation-One dimensional heat equation (Crank Nicholson scheme). Solution of Hyperbolic equation-wave equation.(Method of finite differences)	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern
(End semester examination)

Time : 3 hours **Maximum marks: 100**

The question paper shall consist of Part A, Part B and Part C.

Part A shall consist of three questions of 15 marks each uniformly covering Modules I and II. The student has to answer any two questions (15×2=30 marks).

Part B shall consist of three questions of 15 marks each uniformly covering Modules III and IV. The student has to answer any two questions (15×2=30 marks).

Part C shall consist of three questions of 20 marks each uniformly covering Modules V and VI. The student has to answer any two questions (20×2=40 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
MA488	Cryptography	3-0-0-3	2016

Prerequisite : NIL

Course Objective:

1. To understand the fundamentals of Cryptography
2. To acquire knowledge on standard algorithms used to provide confidentiality, integrity and authenticity.

Syllabus: Number Theory - Divisibility, The Division algorithm, Euclidean Algorithm, GCD, Extended Euclidean Algorithm, Primes and properties, Fundamental theorem of arithmetic (statement and proof), Modular arithmetic, Euler function, Congruence in one unknown, Solution of congruences, Modular inverse. Algebra - Definition and examples of Groups, Rings and Fields and finite fields of the form $GF(p)$ and $GF(2^n)$, Euler's theorem, Fermat's little theorem, The Chinese reminder theorem. Asymmetric encryption: The discrete logarithm problem, Diffie–Hellman key exchange, The Elgamal public key cryptosystem, Elliptic Curve Cryptography. Integer Factorization and RSA: Euler's formula and roots modulo pq, The RSA public key cryptosystem, Implementation and security issues, man-in-the-middle Attack, Primality testing, Miller–Rabin test, Pollard' p − 1 factorization algorithm. Elliptic Curves: Elliptic curves over real numbers, Elliptic curve addition algorithm, Elliptic curves over finite fields, The group of an elliptic curve. The elliptic curve discrete logarithm problem, Elliptic curve cryptography, Elliptic Diffie–Hellman key exchange, Elliptic Elgamal public key cryptosystem.

Expected Outcome:

Students will be able to

1. Learn standard algorithms used to provide confidentiality
2. Understand how secure encryption techniques work
3. Design security applications in the field of information technology.

Textbook:

1. Jeffrey Hoffstein, Jill Pipher and Joseph H. Silverman, An Introduction to Mathematical Cryptography, Springer, 2008
2. William Stallings, Cryptography and Network Security, 5th Edition, Prentice Hall Press Upper Saddle River, NJ, USA, 2010

References:

1 Andreas Enge, Elliptic curves and their applications to cryptography: an introduction, 1st Edition Springer, 1999

2 D. R. Stinson, Cryptography, Theory and practice, Chapman & Hall (2006)

3 R. Lidl and H. Niederreiter, Introduction to finite fields and their applications, Cambridge University Press.

4 Thomas Koshy, Elementary Number Theory with Applications, 2nd Edition, Academic Press, 2007

Module	Syllabus	Hours	End Sem. Exam Marks
I	**Number Theory:** Divisibility, The Division algorithm, Euclidean Algorithm, GCD, Extended Euclidean Algorithm, Primes and properties, Fundamental theorem of arithmetic (statement and proof), Modular arithmetic, Euler function, Congruence in one unknown, Solution of congruences, Modular inverse.	8	15%
II	**Algebra:** Definition and examples of Groups, Rings and Fields and finite fields of the form $GF(p)$ and $GF(2^n)$, Euler's theorem, Fermat's little theorem, The Chinese reminder theorem.	6	15%

FIRST INTERNAL EXAMINATION			
III	**Symmetric encryption:** Symmetric Cipher Model, Substitution Techniques, Transposition Techniques, Rotor Machines, AES cipher, Multiple Encryption and Triple DES,	6	15%
IV	**Asymmetric encryption:** The discrete logarithm problem, Diffie–Hellman key exchange, The Elgamal public key cryptosystem, Elliptic Curve Cryptography	7	15%
SECOND INTERNAL EXAMINATION			
V	**Integer Factorization and RSA:** Euler's formula and roots modulo *pq,* The RSA public key cryptosystem, Implementation and security issues, man-in-the-middle Attack, Primality testing, Miller–Rabin test, Pollard' $p - 1$ factorization algorithm	8	20%
VI	**Elliptic Curves:** Elliptic curves over real numbers, Elliptic curve addition algorithm, Elliptic curves over finite fields, The group of an elliptic curve. The elliptic curve discrete logarithm problem, Elliptic curve cryptography, Elliptic Diffie–Hellman key exchange, Elliptic Elgamal public key cryptosystem	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN
(End semester examination)

The question paper shall consist of Part A, Part B and Part C.

Part A shall consist of three questions of 15 marks each uniformly covering Modules I and II. The student has to answer any two questions (15×2=30 marks).

Part B shall consist of three questions of 15 marks each uniformly covering Modules III and IV. The student has to answer any two questions (15×2=30 marks).

Part C shall consist of three questions of 20 marks each uniformly covering Modules V and VI. The student has to answer any two questions (20×2=40 marks)

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME471	Optimization Techniques	3-0-0-3	2016

Prerequisite - ME372 Operations Research

Course Objective:

- To learn the various optimization techniques for effective decision making.

Syllabus:

Linear programming – integer programming– network models – goal programming – dynamic programming – nonlinear programming – nontraditional optimization.

Expected Outcome:

- The students will be able to understand optimization techniques and apply them in solving practical problems

Text Books:

1. Miller, D. M. and Schmidt, J. W., Industrial Engineering and Operations Research, John Wiley & Sons, Singapore, 1990.
2. Paneerselvam, R., Operations Research, Prentice Hall of India, New Delhi, 2008.
3. Pannerselvam, R., Design and Analysis of Algorithms, Prentice Hall of India, New Delhi, 2007.
4. Taha, H. A., Operations Research, Pearson, 2004.

Reference Books:

1. Banks, J., Carson, J. S., Nelson, B. L., and Nicol, D. M., Discrete-Event System Simulation, Third Edition, Pearson Education, Inc., 2001
2. Goel, B. S. and Mittal, S. K., Operations Research, Pragati Prakashan, Meerut, 1999.
3. Ravindran, Phillips and Solberg, Operations Research Principles and Practice, Willey & Sons, 1987
5. Srinivasan, G. "Operations Research-Principles and Applications", latest edition, PHI Pvt. Ltd.

Course Plan

Module	Contents	Hours	End Sem. Exam. Marks
I	Review of linear programming– revised simplex method	1	15%
		1	
	Dual simplex method	1	

		1	
	Sensitivity analysis – changes affecting feasibility – changes affecting optimality	**1**	
		1	
		1	
II	Integer programming – importance – applications	**1**	**15%**
	Branch and bound technique	**1**	
		1	
	Gomory's cutting plane method	**1**	
		1	
	Solution to travelling salesman problem	**1**	
		1	
FIRST INTERNAL EXAMINATION			
III	Network models – minimal spanning tree problem	**1**	**15%**
	PRIM's algorithm	**1**	
	Kruskal's algorithm	**1**	
	Shortest route problem –applications	**1**	
	Systematic method	**1**	
	Dijkstra's algorithm	**1**	
	Floyd's algorithm	**1**	
IV	Goal programming – goal programming formulation-application.	**1**	**15%**
		1	
	Simplex method for solving goal programming	**1**	
		1	
	Dynamic programming – terminologies – forward and backward recursion –applications	**1**	
	Shortest path problems	**1**	
		1	
SECOND INTERNAL EXAMINATION			
V	Nonlinear programming – convex, quasi-convex, concave and unimodal functions – theory of constrained optimization	**1**	**20%**
		1	
		1	
	Lagrangean method	**1**	
		1	
	Kuhn-Tucker conditions	**1**	
		1	
VI	Nontraditional optimization – computational complexity- Introduction to metaheuristics – areas of application	**1**	**20%**
		1	
	Genetic algorithm (GA) – terminologies – steps and examples	**1**	
	Tabu search (TS) – steps and examples	**1**	
	Simulated annealing (SA) – steps and examples	**1**	
	Ant colony optimization (ACO) – steps and examples - Particle Swarm Optimization (PSO)-Steps and examples	**1**	
		1	

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME482	Energy Conservation and Management	3-0-0-3	2016

Prerequisite : Nil

Course Objectives: :

1. To enable analysis of the energy data of industries, energy accounting and balancing
2. To know energy audit and methodologies for energy savings
3. To understand utilization of the available resources in optimal ways

Syllabus:

Energy, Power, Past & Present scenario of World; National Energy consumption Data, Components of EB billing, Boilers, Furnaces and Thermic Fluid Heaters, Pumps, Fans, Blowers, Energy audit, Energy Economics

Expected Outcomes:

The students will be able to

i. carryout energy accounting and balancing
ii. suggest methodologies for energy savings

Text books:

1. Callaghn, P.W. Design and Management for Energy Conservation, Pergamon Press, Oxford,1981.
2. Witte. L.C., P.S. Schmidt, D.R. Brown, Industrial Energy Management and Utilisation, Hemisphere Publ, Washington, 1988.

References:

1. Dryden. I.G.C., The Efficient Use of Energy Butterworths, London, 1982
2. Energy Manager Training Manual (4 Volumes) available at www.energymanager training.com, a website of Bureau of Energy Efficiency (BEE), A statutory body under Ministry of Power, Government of India, 2004.
3. Murphy. W.R. and G. Mc KAY, Energy Managemen", Butterworths, London 1987.
4. Turner. W.C., Energy Management Hand book, Wiley, New York, 1982.

Module	Contents	Hours	End Sem. Exam. Marks
I	Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization –Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing	7	15%

II	Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.	**7**	**15%**
FIRST INTERNAL EXAMINATION			
III	Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &Usage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories	**7**	**15%**
IV	Energy efficiency in Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, Bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering	**7**	**20%**
V1	Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concepts	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME484	Finite Element Analysis	3-0-0-3	2016

Prerequisite : Nil

Course Objectives: :

1. To introduce the concepts of Mathematical Modeling of Engineering Problems.
2. To appreciate the use of FEA to a range of Engineering Problems.

Syllabus:

Historical Background, Mathematical Modeling of field problems in Engineering ,Governing Equations, Basic concepts of the Finite Element Method, Solution of problems from solid mechanics and heat transfer, Fourth Order Beam Equation, Second Order 2D Equations involving Scalar Variable Functions, Equations of elasticity, Natural co-ordinate systems

Expected Outcomes:

- The students will be able to understand different mathematical techniques used in FEM analysis and use them in Structural and thermal problems

Text books:

1. Reddy. J.N., An Introduction to the Finite Element Method, 3rd Edition, Tata McGraw-Hill, 2005
2. Seshu, P, Text Book of Finite Element Analysis, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007.

Reference books:

1. Bhatti Asghar M, Fundamental Finite Element Analysis and Applications, John Wiley & Sons,2005 (Indian Reprint 2013)
2. Chandrupatla & Belagundu, Introduction to Finite Elements in Engineering, 3rd Edition, Prentice Hall College Div, 1990
3. Logan, D.L., A first course in Finite Element Method, Thomson Asia Pvt. Ltd., 2002
4. Rao, S.S., The Finite Element Method in Engineering, 3rd Edition, Butterworth Heinemann, 2004
5. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, Concepts and Applications of Finite Element Analysis, 4th Edition, Wiley Student Edition, 2002.

COURSE PLAN

Module	Contents	Hours	End Sem. Exam. Marks
I	Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique	7	15%
II	Basic concepts of the Finite Element Method. One Dimensional	7	15%

	Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices		
FIRST INTERNAL EXAMINATION			
III	Solution of problems from solid mechanics and heat transfer Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.	**7**	**15%**
IV	Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.	**7**	**15%**
SECOND INTERNAL EXAMINATION			
V	Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.	**7**	**20%**
V1	Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.	**7**	**20%**
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100 **Time: 3 hrs**

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
MP469	Industrial Psychology and Organisational Behaviour	3-0-0-3	2016

Course Objectives

- To create a knowledge about human psychology
- To learn about theories of motivation and group behavior.
- To understand the socio-cultural aspects in organizations

Syllabus

Introduction- psychology as a science- study of behaviour- stimulus- response behaviour- heredity and environment- human mind- cognition- character- thinking- attention- memory- emotion- traits- attitude- personality. Organizational behaviour- definition –development- fundamental concept- organizational behaviour system- models - understanding a social-system - managing communication- Motivation- motivation driver - goal setting- expectancy model- comparison models- interpreting motivational models- leadership- path goal model. Special topics in industrial psychology- managing group in organization- group and inter group dynamics- managing change and organizational development- nature planned change- resistance characteristics

Expected outcome.

The students will be able to

i. know the importance of psychology
ii. have insight into individual and group behavior
iii. deal with people in better way
iv. motivate groups and build teams.

Text Book:

Davis K. & Newstrom J.W., *Human Behaviour at work*, Mcgraw Hill International, 1985

References:

1. Blum M.L. Naylor J.C., Horper & Row, *Industrial Psychology*, CBS Publisher, 1968
2. Luthans, *Organizational Behaviour*, McGraw Hill, International, 1997
3. Morgan C.t.,King R.A.,John Rweisz &John Schoples, *Introduction to Psychology*, McHraw Hill, 1966
4. Schermerhorn J.R.Jr., Hunt J.G &Osborn R.N., Managing, *Organizational Behaviour*, John Willy

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction- psychology as a science- area of applications – study of individual- individual differences- study of behaviour- stimulus- response behaviour- heredity and environment- human mind- cognition- character- thinking- attention- memory- emotion- traits- attitude- personality	6	15%
II	Human mind- cognition- character- thinking- attention- memory- emotion- traits- attitude- personality	6	15%
	FIRST INTERNAL EXAMINATION		
III	Organizational behaviour- definition –development- fundamental concept- nature of people nature of organization – an organizational behaviour system- models- autocratic model- hybrid model-	6	15%

IV	Understanding a social-system social culture- managing communication- downward, upward and other forms of communication	6	15%
SECOND INTERNAL EXAMINATION			
V	Motivation- motivation driver- human needs- behaviour modification- goal setting- expectancy model- comparison models- interpreting motivational models- leadership- path goal model- style – contingency approach	9	20%
VI	Special topics in industrial psychology- managing group in organization- group and inter group dynamics- managing change and organizational development- nature planned change- resistance characteristic of OD-OD process	9	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 Time: 3 hrs

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions

Course code	Course Name	L-T-P-Credits	Year of Introduction
MP482	**PRODUCT DEVELOPMENT AND DESIGN**	**3-0-0-3**	**2016**

Prerequisite: Nil

Course Objective

- To create confidence in developing new products.
- To acquaint with methods and tools for product design and development.
- To equip with practical knowledge in conceptualization, design and development of new product.

Syllabus

Introduction to product design, the need of a product, the product life cycle, the product design process. The application of Value Engineering principles in product design. Application of various tools such as CAD, CAE and DFM. The Ergonomics aspects in context of the product design. The fundamental concept of rapid prototyping techniques.

Expected Outcome

The students will be able to

i. create new products suiting the requirements of society.
ii. enhance value addition in products
iii. coordinate multiple factors like market, design, ergonomics manufacturing in creating a new product.

References:

1. Andreas Gebhardt, Rapid Prototyping, Carl Hanser – Verlag, Munich, 2003.
2. Baldwin E N & Neibel B W "Designing for Production." Edwin Homewood Illinois.
3. Bralla J G (Ed.), "Handbook of Product Design for Manufacture, McGraw Hill, NewYork, 1986
4. D. T. Pham, S.S. Dimov, Rapid Manufacturing-The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer – Verlag, London, 2001.
5. David G Ullman, "The Mechanical Design Process." McGraw Hill Inc Singapore 1992
6. Hollins B & Pugh S "Successful Product Design." Butter worths London, 1990
7. Jones J C "Design Methods." Seeds of Human Futures. John Willey, 1970
8. Karl T Ulrich, Steven D Eppinger , " Product Design & Development." Tata McGraw Hill, 2003.
9. Kevin Otto & Kristin Wood Product Design: "Techniques in Reverse Engineering and new Product Development.", Pearson Education New Delhi, 2000
10. N J M Roozenberg , J Ekels , N F M Roozenberg " Product Design Fundamentals and Methods ." John Willey & Sons 1995.

Course Plan

Module	Contents	Hours	End Sem. exam marks
	Introduction: Classification/ Specifications of Products. Product life cycle. Product mix. Introduction to product design. Modern product	7	15%

I	development process. Innovative thinking. Morphology of design.		
II	Conceptual Design: Generation, selection & embodiment of concept. Product architecture. Industrial design: process, need. Robust Design: Taguchi Designs & DOE. Design Optimization	7	15%
First Internal Exam			
III	Design for Manufacturing and Assembly: Methods of designing for Manufacturing and Assembly. Designs for Maintainability. Designs for Environment. Product costing. Ethics in product design, legal factors and social issues.	7	15%
IV	Value Engineering / Value Analysis. : Definition. Methodology, Case studies. Economic analysis: Qualitative & Quantitative.	7	15%
Second Internal Exam			
V	Ergonomics in product design. Aesthetics in product design. Concepts of size and texture, colour .Psychological and Physiological considerations. Creativity Techniques: Creative thinking, conceptualization, brain storming, primary design, drawing, simulation, detail design.	7	20%
VI	Concurrent Engineering, Rapid prototyping: concepts, processes and advantages. Tools for product design – Drafting / Modelling software. Patents & IP Acts. Overview, Disclosure preparation.	7	20%
End Semester Exam			

Question Paper Pattern

Maximum marks: 100 Time: 3 hrs

The question paper should consist of three parts

Part A
There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B
There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C
There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions

Course code	Course Name	L-T-P – Credits	Year of Introduction
MP484	Project management	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- To familiarize the major aspects of project management consisting of : Project Planning, Project Analysis, Project Selection, Project Implementation and Project Review

Syllabus

Planning, capital budgeting, generation of project ideas, Project analysis, Market and demand analysis, Manufacturing process and technology, Project charts, financial analysis, breakeven point, cash flow statement, time value of money, appraisal criteria, Project organisation, network techniques, PERT Model, CPM Model, Network costs

Expected outcome.

The students will be able to

i. Understand Project planning
ii. Analyse market and demand
iii. Familiarise basic concepts of project costing and cash flows
iv. Apply network analysis models of PERT and CPM under different situations

Text Book:

- Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Review, Fourth Edition, Tata McGraw –Hill, 2017

References:

1. Dennis Lock, Project Management, Gower Publishing, 9e, 2007
2. Gido & Clements, Successful Project Management, South-Western College Pub; 6 edition ..2014.
3. Harold.T..Amrine John.A.Ritchey, Colin L. Moodie, Joseph F Kmec Manufacturing Organization and Management, Pearson Education, 1992
4. Parameswar P Iyer, Engineering Project management, Vikas Publishers, 1996
5. Prasanna Chandra, Financial Management Theory and Practice, McGraw –Hill Education, 2017

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Planning - Capital Expenditures – Phases of Capital Budgeting – Levels of decision Making –Facets of Project analysis- Feasibility Study – Objectives of Capital Budgeting – Resource Allocation framework- Key Criteria- Elementary Investment strategies – Portfolio planning tools – Generation of project Ideas – Monitoring the environment – Corporate appraisal – Scouting for project ideas – Preliminary Screening – Project rating index – Sources of Positive net present value	7	15%
II	Analysis – Market and demand analysis – Situational analysis and specification of objectives – Collection of secondary information -	7	15%

	Conduct of market survey – Characterization of Market – demand Forecasting – Market planning – Technical analysis- Material inputs and utilities		
FIRST INTERNAL EXAMINATION			
III	Manufacturing process/technology – Product Mix – Plant capacity – Location and site -machineries and equipments – Structures and civil works – Project charts and layouts – Work schedule – Financial Analysis – Cost of project – means of finance – Estimates of sales and Production – Cost of production – Working capital requirements and its financing – Profitability projections – Breakeven point – projected cash flow statements and balance sheets	7	15%
IV	Project Cash flows – Basic Principles for measuring cash flows – Components of cash flow – Cash flow illustrations – Viewing a project from different points of view – Time value of money – Future Value of a single amount – Future value of an annuity – Present value of a single amount –Present Value of an annuity	7	15%
SECOND INTERNAL EXAMINATION			
V	Cost of capital – Cost of debt capital – cost of preference capital – Rate of return – Cost of external equity and retained earnings - Determination of weights – Appraisal criteria – Net present value – Cost benefit ratio- Internal rate of return- Urgency – payback period	7	20%
VI	Implementation- Forms of Project organization – Project planning – Project control – Human aspects of project management , Network Techniques – Development of Network – Time estimation – Critical path determination – Scheduling under limited resources – PERT Model –CPM Model – Network Cost System – Project review- Initial; review – Performance evaluation – Abandonment analysis	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100 Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV
Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI
Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR482	Mechatronics	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- To provide basic knowledge on principles and design of Mechatronics systems.

Syllabus

Introduction to Mechatronics – Sensors and transducers – Open loop and closed loop control systems - continuous and discrete processes - servo mechanism – principles - components - error detectors - potentiometers- types-Design of modern CNC machines and Mechatronic elements - Machine structure - guide ways – drives – bearings - Measuring system for NC machines - Closed loop controllers - Mechatronics in Robotics - Man-machine interface. Fundamentals of ANN – Stages in designing mechatronic systems - case studies of mechatronics.

Expected outcome .

- The student will acquire basic knowledge on design, and application of Mechatronics systems

Text Book:

W. Bolton, *Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering*, Addison Wesley Longman Limited.

References:

1. R. C. Dorf, R. H. Bishop, *Modern Control Systems*, Addison Wesley
2. Krishna Kant, *Computer Based Industrial Control*, Prentice Hall of Indian Private Limited
3. HMT Limited, *Mechatronics*, Tata McGraw Hill Publishing Company Limited
4. Herbert Taub, Donald Schilling, *Digital Integrated Electronics*, McGraw Hill International Editions
5. Dan Necsulescu, *Mechatronics*, Pearson Education Asia, 2002(Indian reprint).

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Mechatronics – scope - Mechatronics and Engineering Design. Sensors and transducers – classification- thermal- electrical- optical- acoustic- pneumatic- magnetic- and piezo electric sensors- Smart sensors.	7	15%
II	Open loop and closed loop control systems - continuous and discrete processes - servo mechanism – principles - components - error detectors - potentiometers- types.	7	15%
FIRST INTERNAL EXAMINATION			

III	Design of modern CNC machines and Mechatronic elements - Machine structure - guide ways – drives – bearings - anti friction bearings- hydrostatic bearing- hydrodynamic bearing. Measuring system for NC machines - direct and indirect measuring system.	7	15%
IV	Closed loop controllers - proportional- derivative and integral controls - PID controller – digital controllers - controller tuning - adaptive control of machine tools. programmable logic controllers- architecture.	7	15%
SECOND INTERNAL EXAMINATION			
V	Mechatronics in Robotics - robot position and proximity sensing - tactile sensing. Man-machine interface. Fundamentals of ANN – perceptions – back propagation.	7	20%
VI	Stages in designing mechatronic systems - traditional and mechatronic design -possible design solutions - case studies of mechatronic systems - pick and place robot - automatic car park system – engine management system.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100 Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions

(2 x15 = 30 marks)

Course Code	Course name	L-T-P- C	Year of Introduction
MT482	**INDUSTRIAL SAFETY**	**3-0-0-3**	**2016**

Prerequisite: Nil

Course Objective

- To understand the impact of safe industrial operations , its benefits and safety legalization.

Syllabus

Introduction to Industrial safety- responsibility of safety- safety committees- occupational health hazards – Ergonomics hazards- Musculoskeletal disorders- Safety management- PQRS theory – Work place design concepts – Need of machine maintenance- Safety controls- Legal provisions regarding safety – Accident prevention – Rules – Workmen compensation act – public liabilities insurance- Fatal accident act.

Expected Outcome.

The students will

i. gain a general concept of safety,
ii. become aware of safety responsibilities of various agencies,
iii. know the occupational health hazards and human factors contributing to industrial accidents,
iv. learn the concepts of safety management,
v. understand the need for timely maintenance of equipments, the need and measures for industrial safety control
vi. become familiar with the general legal rules for an industrial safety practitioner.

TEXT BOOKS/REFERENCES

1. Frank P. Lees, Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth-Heinemann Ltd., London (1991).
2. Grimaldi and Simonds , Safety Management, AITBS Publishers, New Delhi (2001)
3. Industrial Safety -National Safety Council of India.
4. R.K.Jain and Sunil S.Rao, Industrial Safety, Health and Environment Management Systems, Khanna Publishers, New Delhi (2006)
5. Slote.L. Handbook of Occupational Safety and Health, John Willey and Sons, New York
6. The Factories Act with amendments 1987, Govt. of India Publications DGFASLI, Mumbai

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I.	**Introduction to industrial safety** Concept of Safety, Goals of safety engineering, Need for safety engineering, definitions of Accident, injury, unsafe actions &Conditions. Responsibility of Safety - Society, Govt., Management, Union & employees. Duties of safety officer. Safety Committee - Membership, Functions & Scope of Safety committee.	**5**	**15%**

II	**Safety and Health Management:** Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety. Ergonomics - Introduction, Definition, Objectives, Advantages. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.. Importance of Industrial safety, role of safety department, Safety committee and Function.	**7**	**15%**
FIRST INTERNAL EXAMINATION			
III	Safety Awareness & Training:Training for Safety: Assessment of needs. Design & development of training programme. Training methods and strategies. Training of manager, supervisors & workers. Evaluation of training programmes. Human behaviour and safety: Human factors contributing to accidents.	**7**	**15%**
IV	**Safety Assessment and Control** Safety Management: Role of management in Industrial Safety. Safety Management- Principles & Practices. Safety Organization: Role of safety committee and its formation, Safety awareness programme: motivation, education and training, Appraisal of plant safety and measurement of safety performance, Total loss control concept, Introduction to productivity, Quality, Reliability, and Safety (PQRS) theory. Concept of workplace and its design. Improving safety and productivity through work place design control measures. Technical and engineering control measures. Control measures against human error. Preventive maintenance. Role of Preventive maintenance in safety and health. Standards and code of practices for plant and equipment.	**9**	**15%**
SECOND INTERNAL EXAMINATION			
V	**Industrial Safety and Control** Control of Physical Hazards: (Purpose of lighting. Advantages of good illumination. Lighting and safety. Lighting and the work. Control of Chemical Hazards Hazardous properties of chemicals and appreciation of information provided in Material safety data sheets. Classification of dangerous materials with pictorial symbols, common hazard and common precautions for each class Control of Electrical Hazards Dangers from electricity. Safe limits of amperages, Voltages Safe distance from lines. Capacity and protection of conductors, Joints and connections, Means of cutting of power overload and short circuit protection. Statutory provisions regarding fire safety. Factors contributing towards fire. Chemistry of fire. Classification of fires. Common causes of industrial fires.	**9**	**20%**
VI	**Safety Legalisation** Legal Provisions regarding safety, Accident prevention & Compensation to affected employees as under Factories Act-1948, Factories Act(Amendment)1987, Maharashtra Factories Rule-	**5**	**20%**

	1963,The Mines Act-1952,Maharashtra Safety Officers Rule-1982,The Workmen CompensationAct-1923,ESI Act, Public Liabilities Insurance Act-1991,Fatal Accident Act.		
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN

Maximum Marks :100 Examination Duration: 3 hrs.

PART A: 8 questions from Module 1&2 (4+4) – 6 questions to be answered. 6 X 5 = 30 marks
PART B: 8 questions from Module 3&4 (4+4) – 6 questions to be answered. 6 X 5 = 30 marks
PART C: 6 questions from Module 5&6 (3+3) – 4 questions to be answered. 4 X 10 = 40 marks

Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB482	DREDGERS AND HARBOUR CRAFTS	3-0-0-3	2016

Prerequisites: -Nil-

Course Objectives:

- To impart various aspects of dredging
- To introduce various aspects of operation of dredgers and harbor crafts

Syllabus:

Types of Dredging Equipment, Types of Dredgers, Trailing suction hopper dredger, The cutter suction dredgers, Plain suction dredgers, Barge unloading dredgers, Bucket dredgers, Grab or Clamshell dredgers, Backhoe or dipper dredgers, Navigation Aids Vessels, Tugsand Towboats, Firefighting tugs, Barges, pilot boats, Salvage/buoy vessels, Construction Support Vessels, Fireboats, Patrol and Rescue Vessels, Pollution Response Vessels, Floating docks

Expected Outcome:

The students will be able to:

1. Understand different types of dredging and dredging equipment
2. Analyse the design aspects of 7 types of dredgers
3. Know theoperational aspects of dredgers
4. Understand the design and operational philosophy of harbor craft, including floating dock

Text Books: Ship Design and Construction, Volume II, SNAME 2004

Reference Books:

- Lloyds Register of Shipping, Rules and Regulations for the Classification of Ships - July 2015;
- R N Bray, A D Bates, J M Land, Dredging – A Handbook for Engineers, Butterworth Heinemann, 1996
- D Esima, Dredging in Coastal Waters, Taylor & Francis Group, 2005
- Rolt Hammond , Modern Dredging Practice, Muller, London, 1969
- Denis Yell , ICE Design and Practice guide – Dredging , ASCE, 1995

Course Plan:

Module	Content	Hours	End Sem. Exam Marks
I	Introduction, Types of Dredging Equipment, Types of Dredgers	2	15%
	Harbour/ Port support vessels	2	
	Small Workboats	2	
II	Dredging process	2	15%
	Introduction to dredging equipment, Types, Mechanical Dredgers, Hydraulic dredgers	2	
	Trailing suction hopper dredger– General description, design, technical construction, strength and stability, Dredging process	3	

FIRST INTERNAL EXAMINATION			
III	The cutter suction dredgers - General description, design, Dredging equipment, Drives, Spud systems, technical construction, Dredging process	3	15%
	Plain suction dredgers – Types, working method, design, layout, Technical construction, Dredging process	3	
	Barge unloading dredgers - General description, design, , layout, Technical construction, Dredging process	3	
IV	Bucket dredgers - General description, Area of application, method of working, design, Technical construction, Dredging process	3	15%
	Grab or Clamshell dredgers – Working method, Areas of application, Design aspects, layout, production capacity	3	
	Backhoe or dipper dredgers - General considerations, Working method, Area of application, Main Layout, Production capacity	3	
SECOND INTERNAL EXAMINATION			
V	Major features of following harbor crafts:- Navigation Aids Vessels	2	20%
	Tugsand Towboats, Firefighting tugs	2	
	Barges, pilot boats	2	
VI	Major features of following harbor crafts:- Salvage/buoy vessels	1	20%
	Construction Support Vessels	2	
	Fireboats, Patrol and Rescue Vessels	2	
	Pollution Response Vessels, Floating docks	1	
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks : 100 Exam Duration: 3 Hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 complete questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each complete question can have maximum of 4 subsections.