ACADEMIC REGULATIONS
PROGRAM STRUCTURE
AND
DETAILED SYLLABUS

MECHANICAL ENGINEERING DEPARTMENT

(Applicable For Batches Admitted From 2021 – 2022)

M.TECH.
Machine Design (MD)

VIGNAN'S INSTITUTE OF INFORMATION TECHNOLOGY
(AUTONOMOUS)
DUVVADA - VISAKHAPATNAM – 530 049

(An Autonomous Institute, Accredited by NAAC, Affiliated to JNTUK, Kakinada, AP)

VIGNAN'S INSTITUTE OF INFORMATION TECHNOLOGY
(AUTONOMOUS)

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ACADEMIC REGULATIONS
(VR 21)

VIGNAN'S INSTITUTE OF INFORMATION TECHNOLOGY (AUTONOMOUS)

VISAKHAPATNAM

ACADEMIC REGULATIONS for M. Tech. (Regular)

(Applicable for the batches admitted from 2021 onwards)

The selection for category A and B seats shall be as per Govt. of Andhra Pradesh rules.

1. Award of M. Tech. Degree

A student will be declared eligible for the award of the M. Tech. Degree if he/she fulfills the following academic regulations.

Pursued a course of study for not less than two academic years and not more than four academic years.

Candidate has to register for 68 credits and shall secure 68 credits with all courses.

Students who fail to register for their two years course of study within four years or fail to acquire the 68 credits for the award of the degree within four academic years from the year of their admission shall forfeit their seat in M. Tech course and their admission shall stand cancelled.

2. Programs of Study

The following programs of study are offered at present for specialization in the M. Tech. Course.

Specialization Code	Specialization	Department
15	Machine Design (MD)	Mechanical Engineering (ME)
22	Transportation Engineering (TE)	Civil Transportation (CE)
25	Software Engineering (SE)	Computer Science & Engineering (CSE)
38	Digital Electronics & Communication Systems (DECS)	Electronics & Communication Engineering (ECE)
40	Information Technology (IT)	Information Technology (IT)
42	Power & Industrial Drives (P & ID)	Electrical & Electronics Engineering (EEE)
58	Computer Science & Engineering (CSE)	Computer Science & Engineering (CSE)
70	Electronics & Communication Engineering (ECE)	Electronics & Communication Engineering (ECE)
79	Artificial Intelligence and Machine learning	Computer Science & Engineering (CSE)

And any other courses as approved by the Board of studies and Academic council from time to time.

3. Registration

A student shall register for courses in each semester as per the courses offered by the concerned department.

4. Curricular Program

The Curriculum of the two-year M. Tech Course has been designed to achieve a healthy balance between theory & lab hours, industry experience and to develop technical skills required for a career in the industry or a career in research.

5. Distribution and Weightage of Marks

Theory Courses including electives (100Marks)

For the theory subjects 70 marks shall be awarded based on the performance in the End Semester Examination and 30 marks shall be awarded based on the Internal Evaluation. The internal evaluation shall be made based on the average of the marks secured in the two Mid Term-Examinations conducted-one in the middle of the Semester and the other immediately after the completion of instruction.

The semester end examinations will be conducted for 70 marks consist of five questions carrying 14 marks each. Each of these questions is from one unit and may contain sub-questions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.

Laboratory Course (100Marks)

For practical subjects, 70 marks shall be awarded based on the performance in the End Semester Examinations and 30 marks shall be awarded based on the day-to-day performance as Internal Marks.

a) Internal 30 marks shall be awarded as follows:
   i) Day to day assessment including record – 10 marks
   ii) Internal examination – 20 marks
b) External examination shall be conducted for 70 marks.
   i) Aim, theory and procedure – 15marks, ii) Execution – 25 marks
   iii) Results/Program output – 15 marks, iv) Viva-voce – 15 marks

External Laboratory examinations for M. Tech courses must be conducted with two Examiners. Laboratory class teacher acts as internal examiner and external examiner shall be appointed by the Chief Superintendent of Examinations from the panel of experts recommended by the HOD.

Mini project with seminar (100 Marks)

For Mini Project with Seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Project Review Committee (PRC) consisting of Head of the Department, supervisor/mentor and two other senior faculty members of the department. For Mini Project with Seminar, there **will be only internal evaluation** of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

Mini project report is evaluated for 100 marks.

a) Assessment by the supervisor /guide for 30 marks
b) Assessment by PRC for 40 marks (20 marks x 2 reviews)
c) Seminar presentations for 30 marks (department level committee assessment)

Industry oriented MOOCs course for not less than FOUR weeks can be considered as equivalent. The list of courses in such case shall be approved by Head of the department concerned. The registered course must not be same as any of the courses listed in the program structure of their regulation till final year.

Marks/grades are awarded based on the performance in viva voce or written examination conducted for Coursera courses and online courses other than SWAYAM/NPTEL where there is no end examination.

Audit courses: List of the audit courses will be notified from time to time. An indicative list of the courses is as shown below.

All audit courses will be "Pass/Fail" courses with no specific credit point allotted. The result of the student in the audit course will be notified in the marks memo. A student must pass all the audit courses registered to be eligible for the award of M.Tech. degree.
Note: Audit course will be totally internal evaluation. Mid and End semester examinations shall be conducted for all Audit courses. It is mandatory to pass all Audit Courses**.**

Project/Dissertation

Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Project Review Committee (PRC).

i) Continuous assessment of Dissertation-I and Dissertation-II during the semester(s) will be monitored by the PRC.

ii) **Dissertation- I/Industrial project**: In Dissertation- I, literature review, design calculations and a prototype model are to be prepared within 16 weeks.

iii) In case of Industrial project, students have to complete coursework related to the particular semester through MOOCs

iv) The evaluation of Dissertation-I/Industrial project will be purely internal for 100 marks based on the presentation of literature review, design calculations and demonstration of prototype model.

v) In **Dissertation – II**, experimentation, analysis (analytically or using modern software tools), results & discussion and conclusions are to be prepared and submitted.

vi) A candidate shall submit his status report after each review. Minimum three reviews at PRC level shall be conducted in a gap of one month each for both Dissertation – I & II.

vii) Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the external examiner who adjudicated the Thesis. The Board shall jointly evaluate the candidate's work for a maximum of 100 marks.

6. Attendance Requirements

Aggregate 75% of the attendance is required for promotion to next semester.

Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted by the College Academic Committee based on genuine medical grounds. ***This privilege is given to any student only once during the entire program of study.***

A stipulated fee shall be payable towards condonation of shortage of attendance.

Shortage of attendance may be considered for the students who participate in prestigious sports, co-curricular and extra-curricular activities if their attendance is in the minimum prescribed limit.

Note: Shortage of Attendance below 65% in aggregate shall not be condoned in any case.

7. Academic Requirements

The following academic requirements have to be satisfied in addition to the attendance requirements.

For all courses**,** student is considered to be passed upon securing minimum 40% marks in the external examination alone and minimum 50% marks from both internal and external examination put together.

Note: For courses where there is no internal evaluation pass mark is 50% from external & vice-versa.

8. Supplementary Examinations

There is no supplementary examination for PG course.

9. Examinations and Evaluation

9.1. General guidelines

i. All the semester end examinations are conducted for duration of three hours under the supervision of the Chief Superintendent of Examinations.

ii. **Pattern of end examination paper (for theory courses):**

a. External examination shall be conducted for 70 marks.

b. The semester end examinations will be conducted for 70 marks consist of five questions carrying 14 marks each. Each of these questions is from one unit and may contain sub-questions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.

iii. Dean of Evaluation, who reports to the Chief Superintendent of Examinations is responsible for planning, conduct of the examinations and declaring results etc.,

iv. The Controller of the examinations ensures that all the four sets of question papers received from the external paper setters comply with the guide lines.

v. Chief Superintendent of Examinations picks up a question paper at random from a set of four papers submitted by the Controller of the Examinations, three hours before the commencement of the examinations.

vi. Moderation: Moderation is carried in order to verify whether all the questions given fall within the framework of prescribed syllabus and Unit wise distribution.

vii. Controller of the Examinations with the support of Additional Controller of Examinations gets the question papers printed course-wise in the required number.

viii. With the help of special invigilators, question papers are distributed to the examination halls five minutes prior to the commencement of Examination.

ix. Special Inspection Squad headed/nominated by Chief Superintendent of Examination makes surprise visit to the Examination Halls to ensure the proper conduct of Examination.

x. The spot valuation is completed within 15 days after the conduct of every examination by following the regular process of coding and decoding of the answer scripts.

xi. Chief Examiner / Evaluators for the respective courses are identified and nominated by the Head of the Department. Evaluators will comprise of internal and external course experts.

xii. Two level evaluation methodologies are adopted for the sake of paper evaluations with one internal and one external evaluator. If the difference of the marks from both the evaluations is more than 15%, then such papers are sent for third evaluation. If the difference of the marks awarded by the internal expert and the external expert is less than or equal to 15% then the highest mark among the two is awarded for the student.

xiii. For laboratory examinations, the evaluation is done by internal examiner and one external examiner.

xiv. Results shall be announced within 30 days after the completion of the last examination.

9.2. Revaluation

There is a provision for revaluation of theory courses if student fulfils the following norms.

The request for revaluation must be made in the prescribed format duly recommended by the Chief Superintendent of Examination through Additional Controller along with the prescribed revaluation fee.

9.3. Challenge Revaluation

If the student is very confident, there is a provision for challenge revaluation for the courses as per the following norms.

i. The challenge revaluation will be carried out by a three-member committee comprising of an external course expert nominated by Principal / Chief Superintendent of Examinations, the faculty member who taught the course chosen by student from the same institute and the third member is the Head of the respective department/faculty nominated by HOD.

ii. The candidate will forfeit the challenging revaluation fee if the difference in the marks awarded by the committee and the initial awarded marks is not more than or equals to 15%. If the difference in marks is more than 15%, the challenge fee will be returned to the candidate. The marks awarded in the Challenge revaluation will be the final.

10. Grading System

Absolute grading system shall be followed for the award of grades

Grade Point

It is a numerical weight allotted to each letter grade on a 10-point scale.

Grades and Grade Points

Marks Range (in %)	Letter Grade	Level	Grade Point
≥ 90	O	Outstanding	10
≥80 to <90	A	Excellent	9
≥70 to <80	B	Very Good	8
≥60 to <70	C	Good	7
≥50 to <60	D	Satisfactory	6
<50	F	Fail	0
		Absent	-1
		Withheld	-2
		Malpractice	-3

Computation of SGPA

The following procedure is to be adopted to compute the Semester Grade Point Average. (SGPA) and Cumulative Grade Point Average (CGPA):

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.

$$SGPA\ (Si) = \Sigma(Ci \times Gi) / \Sigma Ci$$

Where Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th}course.

Computation of CGPA

- The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme,i.e.
- $CGPA = \Sigma(Ci \times Si) / \Sigma Ci$
- Where Si is the SGPA of the i^{th} semester and Ci is the total number of credits in that semester.
- Equivalent Percentage = (CGPA – 0.75) X10

11. Award of Class

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of M. Tech. Degree, he shall be placed in one of the following three classes:

Class Awarded	CGPA to be secured	
First Class with Distinction	≥ 7.75 with no subject failures	**Based on CGPA secured from 68 Credits**
First Class	≥ 6.75	
Second Class	≥ 5.75 to < 6.75	

12. General Instructions

Where the words 'he', 'him', 'his', occur they imply 'she', 'her', 'hers', also.

The academic regulations should be read as a whole for the purpose of any interpretation.

In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Chairman, Academic Council is final.

The college may change or amend the academic regulations or syllabi from time to time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the college.

13. Transitory Regulations

If a student is detained and has to get Re-admitted and follow the same regulation of year

of admission.

Transcripts

After successful completion of the entire program of study, a transcript containing performance of all academic years will be issued as a final record. Partial transcript will also be issued up to any point of study to a student on request, after payment of requisite fee.

The Academic Calendar consisting of instruction period of the program is released for every academic year before the commencement of the class work.

There shall be no program transfers after the completion of the admission process. There shall be no transfer from one college/stream to another.

14. Withholding of Results

If the student has not paid the fee dues, if any, to the Institute or in any case of indiscipline is pending against him, the result of the student will be withheld. His degree will be withheld in such cases.

15. Disciplinary Action Guidelines for Malpractices

S.No	Nature of Malpractices/ Improper conduct	Punishment
1 (a)	If the candidate possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the course of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the course of the examination)	Expulsion from the examination hall and cancellation of the performance in that course only.
(b)	If the candidate gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that course only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2	If the candidate has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the course of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the courses of that Semester/year. The Hall Ticket of the candidate is to be cancelled.
3	If the candidate impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate, who has been impersonated, shall be cancelled in all the courses of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining courses of that semester/year. The candidate is also debarred for two

		consecutive semesters from class work and all examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4	If the candidate smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5	If the candidate uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that course.
6	If the candidate refuses to obey the orders of the Chief Superintendent/Assistant - Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that course and all other courses the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the courses of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.

	amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	
7	If the candidate leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that course and all the other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8	If the candidate possesses any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester/year. The candidate is also debarred and forfeits the seat.
9	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the college, expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the courses of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and. a police case will be registered against them.
10	If the candidate comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that course and all other courses the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations

		of the courses of that semester/year.
11	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that course and all other courses the candidate has appeared including practical examinations and project work of that semester/year examinations.
12	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the Academic committee of the Institute for further action to award suitable punishment.	

15.1. For Malpractices identified by squad or special invigilators

Punishments to the candidates will be given as per the above guidelines.

16. UGC recommended punishment for Ragging

i. Suspension from attending classes and academic privileges

ii. Withholding/withdrawing scholarships/fellowship and other benefits.

iii. Debarring from appearing in any test/examination or other evaluation process

iv. Withholding results

v. Debarring from representing the institution in any regional, national or international meet, tournament, youth festival etc.

vi. Suspension/expulsion from the hostel

vii. Cancellation of admission

viii. Rustication from the institution for period ranging from 1 to 4semesters.

ix. Expulsion from the institution and consequent debarring from admission to any other institution for a specified period.

x. Fine may extend up to Rs. 2.5lakh.

PROGRAM STRUCTURE & DETAILED SYLLABUS
M.Tech. (Mech. Engg.)
For
MACHINE DESIGN PROGRAM

(Applicable for batches admitted from 2021-2022)

VR 21 - Program Structure for Machine Design
Department of Mechanical Engineering

I Year - I Semester							
S.No	**Course Code**	**Subject**		**L**	**T**	**P**	**Credits**
1	2015211100	Advanced Mechanics of Solids		3	1*	0	3
2	2015211101	Mechanical Vibrations and Acoustics		3	1*	0	3
3	2015211150	**Programme Elective – I**	Design of Automobile Systems	3	1*	0	3
	2015211151		Product Design				
	2015211152		Design for Manufacturing & Assembly				
	2015211153		Fracture Mechanics				
	2015211154		Advanced Mechanisms				
4	2015211155	**Programme Elective – II**	Non-Destructive Evaluation	3	0	0	3
	2015211156		Robotics				
	2015211157		Geometric Modeling				
	2015211158		Multi Body Dynamics				
	2015211159		Gear Engineering				
5	2015211110	Machine Dynamics Lab		0	0	4	2
6	2015211111	Design Practice Lab-I		0	0	4	2
7	2000211100	Research Methodology and IPR		2	0	0	2
8	2000211130	Soft Skills		2	0	0	0
Total							**18**

I Year - II Semester							
S.No.	**Course Code**	**Courses**		**L**	**T**	**P**	**Credits**
1	2015211200	Advanced Finite Element Methods		3	1*	0	3
2	2015211201	Advanced Machine Design		3	1*	0	3
3	2015211250	**Program Elective – III**	Theory of Plasticity	3	1*	0	3
	2015211251		Signal Analysis and Condition Monitoring				
	2015211252		Computational Fluid Dynamics				
	2015211253		Composite Materials				
	2015211254		Continuum Mechanics				
4	2015211255	**Program Elective –IV**	Experimental Techniques and data analysis	3	0	0	3
	2015211256		Design with advanced Materials				
	2015211257		Design Synthesis				
	2015211258		Tribology				
	2015211259		Experimental Modal Analysis				
5	2015211210	Computational Mathematics Lab		0	0	4	2
6	2015211211	Design Practice Lab-II		0	0	4	2
7	2000211230	**Constitution of India (Audit Course)**		2	0	0	0
8	2015211270	Mini Project with Seminar		0	0	4	2
Total credits							**18**

II Year – Sem- I							
S. No	**Course code**	**Courses**		**L**	**T**	**P**	**Credits**
1	2015212150	**Program Elective-5**	Industrial Robotics	3	1*	0	3
	2015212151		Advanced Optimization Techniques				
	2015212152		Additive Manufacturing				
	2015212153		Mechanics of Composite Materials				
	2015212154		Pressure Vessel Design				
2		**Open Elective**	Should register for courses offered by other departments	3	0	0	3
3	2015212170	**Project Phase -I/ Industrial Project #**		0	0	20	10
Total Credits							**16**

Students going for Industrial project / Thesis will complete Program elective and open elective courses through MOOCs

II Year – Sem- II						
S. No	**Course code**	**Courses**	**L**	**T**	**P**	**Credits**
1	2015212270	**Project Phase -II**	0	0	32	16

Courses offered by Mechanical Engineering Department to other departments as Open electives.

S. No	**Course Code**	**Course**	**L**	**T**	**P**	**Credits**
1	2015212150	Industrial Robotics	3	0	0	3
2	2015212160	Operations Research	3	0	0	3
3	2015212152	Additive Manufacturing	3	0	0	3
4	2015211255	Experimental Techniques and Data Analysis	3	0	0	3

M.Tech.
Detailed Syllabus

I Year I Semester
Detailed Syllabus

Course Code	ADVANCED MECHANICS OF SOLIDS	L	T	P	C
2015211100		3	1*	0	3

Course Objectives:

- Stress, Strain, Temperature diagrams
- Study of different failure criteria
- Conceptualize the unsymmetrical bending
- Survey the various torsions on the bodies

Course Outcomes:

After the completion of the course, student will be able to

- Solve stress, strain calculations.
- Examine different failure criteria for different members
- Evaluate the various parameters to stop unsymmetrical bending
- Compile the torsion coming on to the machine components

UNIT I:

Theories of stress and strain, Definition of stress at a point, stress notation, principal stresses, other properties, differential equations of motion of a deformable body, deformation of a deformable body, strain theory, principal strains, strain of a volume element, small displacement theory.
Stress –strain temperature relations: Elastic and non-elastic response of a solid, first law of thermodynamics, Hooke's Law, Anisotropic elasticity, Hooke's Law, Isotropic elasticity, initiation of Yield, Yield criteria.

UNIT II:

Failure criteria: Modes of failure, Failure criteria, Excessive deflections, Yield initiation, fracture, Progressive fracture, (High Cycle fatigue for number of cycles $N > 10^6$, buckling.
Application of energy methods: Elastic deflections and statically indeterminate members and **Structures:** Principle of stationary potential energy, Castiglione's theorem on deflections, Castiglione's theorem on deflections for linear load deflection relations, deflections of statically determinate structures.

UNIT III:

Unsymmetrical bending: Bending stresses in Beams subjected to Nonsymmetrical bending; Deflection of straight beams due to nonsymmetrical bending.
Curved beam theory: Winkler Bach formula for circumferential stress – Limitations – Correction factors –Radial stress in curved beams – closed ring subjected to concentrated and uniform loads-

stresses in chain links.

UNIT IV:

Torsion: Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section; Hollow thin wall torsion members, multiply connected Cross Section.

UNIT V:

Contact stresses: Introduction; problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Method of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact, Normal and Tangent to contact area.

Text Books:

1. Advanced Mechanics of materials by Boresi & Sidebottom-Wiely International.
2. Theory of elasticity by Timoschenko S.P. and Goodier J.N. McGraw-Hill Publishers 3rd Edition
3. Advanced Mechanics of Solids, L.S. Srinath

References:

1. Advanced strength of materials by Den Hortog J.P.
2. Theory of plates –Timoshenko.
3. Strength of materials & Theory of structures (Vol I & II) by B.C. Punmia
4. Strength of materials by Sadhu singh.

Course Code	MECHANICAL VIBRATIONS AND ACOUSTICS	L	T	P	C
2015211101		3	1*	0	3

Course Objectives:

- Formulate mathematical models of single and multi-degree of freedom (SDOF, MDOF) systems using Newton's second law, energy principles etc.
- Determine eigen values and eigen vectors of MDOF systems using theoretical and numerical techniques
- Obtain fundamental frequencies of continuous systems like string, bar, beams and Shafts and know about vibrations measuring instruments
- Know the overview of Acoustics and Noise control and noise measuring instruments

Course Outcomes:

After the completion of the course, student will be able to

- Understand the basic concepts of Acoustics and Noise, noise measuring instruments and control the noise using different noise control techniques
- Determine vibratory responses of SDOF systems to different excitations like harmonic, periodic and non-periodic excitation
- Obtain eigen values and eigen vectors of MDOF systems using theoretical and numerical methods
- Analyze for frequency and amplitudes of continuous systems like Bars, Beams and Shafts

UNIT-I:

Introduction: Relevance of and need for vibrational analysis – Basics of SHM - Mathematical modelling of vibrating systems - Discrete and continuous systems - single-degree freedom systems - free and forced vibrations, damped and undamped systems.

UNIT-II:

Multi Degree Freedom Systems: Free and forced vibrations of multi-degree freedom systems in longitudinal, torsional and lateral modes - Matrix methods of solution- normal modes - Orthogonality Principle-Energy methods, Eigen values and Eigen vectors.

UNIT-III:

Continuous Systems: Torsional vibrations - Longitudinal vibration of rods - transverse vibrations of beams - Governing equations of motion - Natural frequencies and normal modes - Energy methods, Introduction to nonlinear and random vibrations.

UNIT-IV:

Basics of Acoustics: Speed of Sound, Wavelength, Frequency, and Wave Number, Acoustic Pressure and Particle Velocity, Acoustic Intensity and Acoustic Energy Density, Spherical Wave propagation, Directivity Factor and Directivity Index, Levels and the Decibel, Addition and subtraction of Sound levels, Octave Bands, Weighted Sound Levels.

UNIT-V:

Noise Measurement and Control: Sound Level Meters, Intensity Level Meters, Octave Band Filters Acoustic Analyzers, Dosimeter, Measurement of Sound Power, Impact of noise on humans, A-Weighting, Noise control strategy, sound absorption and insulation.

Text books:

1. S.S.Rao, “Mechanical Vibrations ", 5th Edition, Prentice Hall,2011.
2. L.Meirovitch, “Elements of vibration Analysis", 2nd Edition, McGraw-Hill, New York,1985.

References:

1. W.T. Thomson, M.D. Dahleh and C Padmanabhan, “Theory of Vibration with Applications”, 5th Edition,Pearson Education, 2008.
2. M.L.Munjal, “Noise and Vibration Control”, World Scientific, 2013.
3. Beranek and Ver, “Noise and Vibration Control Engineering: Principles and Applications”, John Wiley and Sons,2006.
4. Randall F. Barron, “IndustrialNoise Controland Acoustics”,Marcel Dekker, Inc.,2003.

Web Resources:

http://www.nptel.ac.in/courses/112103111

http://www.nptel.ac.in/courses/112103112

Course Code	DESIGN OF AUTOMOBILE SYSTEMS (ELECTIVE I)	L	T	P	C
2015211150		3	1*	0	3

Course Objectives:

- To understand the Conceptual design of automobiles and their structure safety
- Understand design of structural elements, load analysis for different vehicles based on cornering loads.
- Identify Suspension system for ride comfort, methods of mounting suspension systems and design of control systems based on ergonomics.
- Identify and design Safety aspects of automobiles, devices, energy absorbing systems.

Course Outcomes:

After the completion of the course, student will be able to

- Understand the safety and conceptual design of Automobiles.
- Evaluate design of structural elements and load analysis for different vehicles based on cornering loads
- Understand Vehicle ergonomics, Suspension system for ride comfort and methods of mounting suspension systems.
- Analyze Safety aspects of automobiles and energy absorbing systems through testing(lab, field testing).

UNIT I:

Conceptual Design of Automobiles: Body shape definition based on aerodynamic structure safety, sub - systems integration considerations, road load analysis, transmission of road loadsto structure.

UNTI II:

Detail design of structural elements, load analysis for different vehicles, safety consideration, design for bending, torsion conditions, criteria for toppling, based on cornering loads.

UNIT III:

Suspension system integration with vehicle for ride comfort, methods of mounting suspension and power train systems.

UNIT IV:

Driver cabin/seat design, design of control systems based on ergonomics, anthropometry, human factors engineering considerations.

UNIT V:

Safety aspects of automobiles, devices, energy absorbing systems, crash worthiness, legislation relating to safety, vehicle performance requirements, sub systems packaging and verification of vehicle performance through testing (lab, field testing).

Text Books:

1. Donald E.Males, Fundamentals of automobile body structure design(R-394), SAE2011.
2. W.F.Milliker, D.L.Milliker, Maurice Olly, Chassis design: principles an analysis (R-206)SAE2002.
3. J.H Smith, Modern Vehicle System Design.

References:

Course Code	PRODUCT DESIGN (PROGRAMME ELECTIVE – I)	L	T	P	C
2015211151		3	1*	0	3

Course Objectives:

- To understand the basic concept a product design based on the requirement.
- To identify new product requirement based on market survey and make flow chart to make to product.
- Use the computer added tools (CAE, CAD, CAM, etc.) to make the solid model and simulate to check the performance.
- To identify the cost associated with production and optimize the fabrication process.

Course Outcomes:

After the completion of the course, student will be able to

- To understand the basic concept a product design based on the requirement.
- Generate the concept of new product and different fabrication process.
- Make the solid model in virtual platform and evaluate the product using computer software.
- Selecting the correct process of fabrication to optimize the cost and quality.

UNIT I:

Product Design Process: Design Process Steps, Morphology of Design. Problem Solving and Decision Making: Problem-Solving Process, Creative Problem Solving, Invention, Brainstorming, Morphological Analysis, Behavioral Aspects of Decision Making, Decision Theory, Decision Matrix, Decision Trees.
Modeling and Simulation: Triz, Role of Models in Engineering Design, Mathematical Modeling, Similitude and Scale Models, Computer Simulation, Geometric Modeling on Computer, Finite-Element Analysis.

UNIT II:

Product management:
The operation of product management: Customer focus of product management, product planning process, Levels of strategic planning, Wedge analysis, Opportunity search, Product life cycle Life cycle theory and practice.
Product development: Managing new products, generating ideas, Sources of product innovation, Selecting the best ideas, the political dimension of product design, Managing the product launch and customer feedback.

Product managers and manufacturing: The need for effective relationships, The impact of manufacturing processes on product decisions, Prototype planning, Productivity potentials, Management of product quality, Customer service levels.

UNIT III:

Risk and Reliability: Risk and Society, Hazard Analysis, Fault Tree Analysis. Failure Analysis and Quality: Causes of Failures, Failure Modes, Failure Mode and Effect Analysis, FMEA Procedure, Classification of Severity, Computation of Criticality Index, Determination of Corrective Action, Sources of Information, Copyright and Copying. Patent Literature.

UNIT IV:

Product Testing; thermal, vibration, electrical, and combined environments, temperature testing, vibration testing, test effectiveness. Accelerated testing and data analysis, accelerated factors. Weibull probability plotting, testing with censored data.

UNIT V:

Design For Maintainability: Maintenance Concepts and Procedures, Component Reliability, Maintainability and Availability, Fault Isolation in design and Self-Diagnostics.
Product Design for Safety, Product Safety and User Safety Concepts, Examples of Safe Designs. Design Standardization and Cost Reduction: Standardization Methodology, Benefits of Product Standardization; International, National, Association and Company Level Standards; Parts Modularization

Text books:

1. Engineering Design, George E. Dieter, McGRAW-HILL
2. Product Integrity and Reliability in Design, John W. Evans and Jillian Y. Evans, Springer Verlag

References:

1. The Product Management Handbook, Richard S. Handscombe, McGRAW-HILL
2. New Product Design, Ulrich Eppinger, 3. Product Design, Kevin Otto.

Course Code	DESIGN FOR MANUFACTURING & ASSEMBLY (PROGRAMME ELECTIVE – I)	L	T	P	C
2015211152		3	1*	0	3

Course Objectives:

- Understanding the basic design rules for manufacturing and material selection.
- Applying the production process for ease of manufacturing.
- Analyze factors for selection of metals and alloys and relationship to manufacturing processes
- Apply the concepts of design for manufacturing and assembly for product manufacturing.

Course Outcomes:

After the completion of the course, student will be able to

- Understand to relate design rules for manufacturability.
- Apply design rules for ease of machining.
- Enumerate the general design considerations for casting, casting tolerances.
- Apply design guidelines to assembly.

UNIT – I:

Introduction to DFM, DFMA: How Does DFMA Work? Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design, Typical DFMA Case Studies, Overall Impact of DFMA on Industry.
Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, Weight on Handling Time, Effects of Combinations of Factors, Application of the DFA Methodology.

UNIT – II:

Machining processes: Overview of various machining processes-general design rules for machining-dimensional tolerance and surface roughness-Design for machining – ease – redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

UNIT – III:

Metal casting: Appraisal of various casting processes, selection of casting process, general design considerations for casting-casting tolerance-use of solidification, simulation in casting design-product design rules for sandcasting.
Extrusion & Sheet metal work: Design guide lines extruded sections-design principles for punching,

blanking, bending, deep drawing-Keeler Goodman forging line diagram – component design for blanking.

UNIT – IV:

Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints- design of brazed joints. Forging: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations.

UNIT – V:

Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated assembly systems, Quantitative analysis of Assembly systems, Multi station assembly systems, single station assembly lines.

Text books:

1. Design for manufacture, John cobert, Adisson Wesley.1995
2. Design for Manufacture byBoothroyd,
3. Design for manufacture, JamesBralla

Reference:

ASM Hand book Vol.20

Course Code	FRACTURE MECHANICS (PROGRAMME ELECTIVE – I)	L	T	P	C
2015211153		3	1*	0	3

Course Objectives:

- Understand various failure modes and characteristics of fractured surfaces
- Know the concept of energy release rate, three loading modes, stress intensity factor in linear elastic fracture mechanics
- Study the concept of failure prediction parameters and crack tip opening displacement
- Analysis of micro mechanisms of fatigue damage, creep deformation, and enlist the factors to be considered for enhancing fatigue resistance.

Course Outcomes:

After the completion of the course, student will be able to

- Identify the prediction of mechanical failure and discuss various failure modes
- Employ the concept of griffith's analysis for energy release rate and describe the concept of stress intensity factor in linear elastic fracture mechanics.
- Analyze failure prediction parameters and crack tip opening displacement in Elastic-Plastic fracture mechanics.
- Assess the fatigue damage and creep damage and illustrate the creep-fatigue interactions.

UNIT-I:

Introduction: Prediction of mechanical failure. Macroscopic failure modes; brittle and ductile behavior. Fracture in brittle and ductile materials – characteristics of fracture surfaces; inter- granular and intra-granular failure, cleavage and micro-ductility, growth of fatigue cracks, The ductile/brittle fracture transition temperature for notched and unnotched components. Fracture at elevated temperature.

UNIT-II:

Griffiths analysis: Concept of energy release rate, G, and fracture energy, R. Modification for ductile materials, loading conditions. Concept of R curves.

Linear Elastic Fracture Mechanics, (LEFM). Three loading modes and the state of stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor, crack tip plasticity, effect of thickness on fracture toughness.

UNIT-III:

Elastic-Plastic Fracture Mechanics; (EPFM): The definition of alternative failure prediction parameters, Crack Tip Opening Displacement, and the J integral. Measurement of parameters and examples of use.

UNIT-IV:

Fatigue: definition of terms used to describe fatigue cycles, High Cycle Fatigue, Low Cycle Fatigue, mean stress R ratio, strain and load control. S-N curves. Goodman's rule and Miner's rule. Micro mechanisms of fatigue damage, fatigue limits and initiation and propagation control, leading to a consideration of factors enhancing fatigue resistance. Total life and damage tolerant approaches to life prediction.

UNIT-V:

Creep deformation: the evolution of creep damage, primary, secondary and tertiary creep. Micro-mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Examples.

Text books:

1. T.L. Anderson, Fracture Mechanics Fundamentals and Applications, 2nd Ed. CRC press, (1995)
2. B. Lawn, Fracture of Brittle Solids, Cambridge Solid State Science Series 2nded1993.

References:

1. J.F. Knott, Fundamentals of Fracture Mechanics, Butterworths(1973)
2. J.F. Knott, P Withey, Worked examples in Fracture Mechanics, Institute ofMaterials.
3. H.L.Ewald and R.J.H. Wanhill Fracture Mechanics, Edward Arnold,(1984).
4. S. Suresh, Fatigue of Materials, Cambridge University Press,(1998)
5. L.B. Freund and S. Suresh, Thin Film Materials Cambridge UniversityPress,(2003).

Course Code	ADVANCED MECHANISMS (PROGRAMME ELECTIVE – I)	L	T	P	C
2015211154		3	1*	0	3

Course Objectives:

- Know the characteristics of various links in mechanism.
- includes the solvation of plane motion with graphical methods.
- analytical methods four bar mechanism at different motion parameters.
- Knowledge on forward & inverse kinematics of different manipulators.

Course Outcomes:

After the completion of the course, student will be able to

- Understand the various degrees of freedom in various linkages of mechanism.
- Analyze the synthesis of mechanism using analytical methods.
- Analyze the plane motion in mechanism graphically.
- Evaluate the manipulator kinematics with D-H notation.

UNIT – I

Introduction:

Elements of Mechanisms; Mobility Criterion for Planar mechanisms and manipulators; Mobility Criterion for spatial mechanisms and manipulators. Spherical mechanisms-spherical trigonometry.

UNIT – II:

Advanced Kinematics of plane motion- I:

The Inflection circle; Euler – Savary Equation; Analytical and graphical determination of d_i; Bobillier's Construction; Collineation axis ; Hartmann's Construction ;Inflection circle for the relative motion of two moving planes; Application of the Inflection circle to kinematic analysis.

Advanced Kinematics of plane motion - II:

Polode curvature; Hall's Equation; Polode curvature in the four bar mechanism; coupler motion; relative motion of the output and input links; Determination of the output angular acceleration and its Rate of change; Freudenstein's collineation –axis theorem; Carter –Hall circle; The circling – point curve for the Coupler of a four bar mechanism.

UNIT – III:

Introduction to Synthesis-Graphical Methods - I:

The Four bar linkage; Guiding a body through Two distinct positions; Guiding a body through Three distinct positions; The Roto center triangle; Guiding a body through Four distinct positions; Burmester's curve.

Introduction to Synthesis-Graphical Methods - II:

Function generation- General discussion; Function generation: Relative –roto center method, Overlay's method, Function generation- Velocity – pole method; Path generation: Hrones's and Nelson's motion Atlas, Roberts's theorem.

UNIT – IV:

Introduction to Synthesis - Analytical Methods:

Function Generation: Freudenstien's equation, Precision point approximation, Precision – derivative approximation; Path Generation: Synthesis of Four-bar Mechanisms for specified instantaneous condition; Method of components; Synthesis of Four-bar Mechanisms for prescribed extreme values of the angular velocity of driven link; Method of components.

UNIT – V:

Manipulator Kinematics:

D-H transformation matrix; Direct and Inverse kinematic analysis of Serial manipulators: Articulated, spherical & industrial robot manipulators- PUMA, SCARA, STANFORD ARM, MICROBOT.

Text books:

1. Jeremy Hirschhorn, Kinematics and Dynamics of plane mechanisms, McGraw-Hill,1962.
2. L. Sciavicco and B. Siciliano, Modelling and control of Robot manipulators, Second edition, Springer -Verlag, London,2000.
3. Amitabh Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines. E. W. P. Publishers.

References:

1. Allen S. Hall Jr., Kinematics and Linkage Design, PHI,1964.
2. J. E. Shigley and J. J. Uicker Jr., Theory of Machines and Mechanisms, McGraw-Hill,1995.
3. Joseph Duffy, Analysis of mechanisms and Robot manipulators, EdwardArnold,1980

Course Code	NON –DESTRUCTIVE EVALIATION (PROGRAMME ELECTIVE – II)	L	T	P	C
2015211155		3	0	0	3

Course Objectives:

- To understand the concept of flaw detection and using various techniques to detect it.
- To learn the overview of X-Ray and Gamma-ray sources and radiation protection
- To impart the knowledge on generation of ultrasonic waves and Ultrasonic flaw evaluation
- To know the principles and practices of Optical holography and electron beam holography techniques.

Course Outcomes:

After the completion of the course, student will be able to

- Identify various surface flaws by using Liquid penetrant inspection and Magnetic particle inspection.
- Apply the systematic understanding of knowledge on radiography techniques.
- Demonstrate comprehensive understanding of Ultrasonic techniques.
- Summarize the various techniques of optical holography and electron beam holography.

UNIT – I:

General Methods: Flaw Detection Using Dye Penetrants. Magnetic Particle Inspection introduction to electrical impedance, Principles of Eddy Current testing, Flaw detection using eddy currents.

UNIT –II:

X-Ray Radiography: The Radiographic process, X-Ray and Gamma-ray sources, Geometric Principles, Factors Governing Exposure, Radio graphic screens, Scattered radiation, Arithmetic of exposure, Radiographic image quality and detail visibility, Industrial X-Ray films, Fundamentals of processing techniques, Process control, The processing Room, Special Processing techniques, Paper Radiography, Sensitometric characteristics of x-ray films, Film graininess signal to noise ratio in radiographs, The photographic latent image, Radiation Protection,

UNIT – III:

Generation of ultrasonic waves, Horizontal and shear waves, Near field and far field acoustic wave description, Ultrasonic probes- straight beam, direct contact type, Angle beam, Transmission/reflection type, and delay line transducers, acoustic coupling and media, Transmission and pulse echo methods, A-scan, B-scan, C-scan, F-scan and P-scan modes, Flaw

sizing in ultrasonic inspection: AVG, Amplitude, Transmission, TOFD, Satellite pulse, Multi-modal transducer, Zonal method using focused beam. Flow location methods, Signal processing in Ultrasonic NDT; Mimics, spurious echos and noise. Ultrasonic flaw evaluation.

UNIT – IV:

Holography: Principles and practices of Optical holography, acoustical, microwave, x-ray and electron beam holography techniques.

UNIT – V:

Applications: NDT in flaw analysis of Pressure vessels, piping, NDT in Castings, Welded constructions, etc., Case studies.

Text books:

1. Ultrasonic testing by Krautkramer and Krautkramer.
2. Ultrasonic inspection 2 Training for NDT: E. A. Gingel, Prometheus Press.
3. ASTM Standards, Vol 3.01, Metals and alloys.

Course Code	ROBOTICS (PROGRAMME ELECTIVE – II)	L	T	P	C
2015211156		3	0	0	3

Course Objectives:

- Understand various robotic configurations and systems.
- Select a robot for a given application and illustrate the working principles of various actuators and sensors that can be used in the manipulator, control system that can be used as well as the method of programming the robot.
- model a given manipulator kinematically and dynamically.
- compute the trajectory equation for given industrial manipulator.

Course Outcomes:

After the completion of the course, student will be able to

- Summarize robot components, configurations and different end effectors.
- Select a robot for a given application and illustrate the working principles of various actuators and sensors that can be used in the manipulator, control system that can be used as well as the method of programming the robot.
- Analyze a given manipulator kinematically and dynamically.
- Derive as well as analyze the equation of trajectory that the end-effector should follow given the boundary conditions.

UNIT – I:

Fundamentals of Robots:

Introduction, definition of robot, classification of robots, History of robotics, robot components, degree of freedom, robot joints, robot coordinates, reference frames, programming modes, robot characteristics, robot work space, robot languages, advantages, disadvantages and applications of robots.

UNIT – II:

Matrix transformations:

Introduction, robots as a mechanism, matrix representation- representation of a point in a space, representation of a vector in space, representation of a frame at the origin of a reference frame, representation of a frame in a reference frame, representation of a rigid body.

Homogeneous transformation matrices, representation of a pure translation, pure rotation about an axis, representation of combined transformations, transformations relative to the rotating, inverse

of transformation matrices.

Robot kinematics:
Forward and inverse kinematics of robots-forward and inverse kinematic equations for position, forward and inverse kinematic equations for orientation, forward and inverse kinematic equations for position and orientation, Denavit-Hartenberg (D-H) representation of forward kinematic equations of robots, The inverse kinematic solution and programming of robots, Degeneracy and Dexterity, simple problems with D-H representation.

UNIT – III:

Differential motions and Velocities:
Introduction, differential relationship, Jacobian, differential motions of a frame-translations, rotation, rotating about a general axis, differential transformations of a frame. Differential changes between frames, differential motions of a robot and its hand frame, calculation of Jacobian, relation between Jacobian and the differential operator, Inverse Jacobian.

UNIT – IV:

Dynamic analysis and forces: Introduction, Lagrangian mechanics, Effective moments of inertia, dynamic equations for multi-degree of freedom robots-kinetic enrgy, potential energy, the Lagrangian, robot's equations of motion, static force analysis of robots.

Trajectory planning: Introduction, path Vs trajectory, basics of trajectory planning, joint space trajectory planning-third order polynomial trajectory planning, fifth order polynomial trajectory planning, Cartesian-space trajectories.

UNIT – V:

Robot Actuators: Introduction, charecterics of Actuating systems-weight, power to weight ratio, operating pressure, stiffness Vs compliance, comparision of actuating systems, hydraulic devices, pneumatic devices, Electric motors-DC motorcar motors, Brushless DC motors, direct Drive electric motors, servomotors, stepped motors.

Robot sensors: Introduction, sensor characteristics, Position sensors-potentiometers, encoders, LVDT, Resolvers, time of travel displacement sensor, Velocity sensors-Encoders, Tachometers, differentiation of position signal, Accelerating sensors, force and pressure sensors-piezoelectric, force sensing resistor, strain gauges, Torque sensors, light and infrared sensors, touch and tactile

sensors, proximity sensors-magnetic proximity sensors, optical proximity sensors, Ultrasonic proximity sensors, inductive proximity sensors, capacitive proximity sensors, eddy current proximity sensors, sniff sensors.

Text books:

1. Introduction to Robotics – Analysis, System, Applications by Saeed B. Niku,PHI Publications
2. Industrial Robotics – Mikell P. Groover & Mitchell Weiss, Roger N. Nagel,NicholasG.Odrey – Mc Graw Hill,1986

References:

1. Robot Modeling and Kinematics – Rachid Manseur, Firewall Media Publishers (An imprint of Laxmi Publications Pvt. Ltd., New Delhi)
2. Robot Analysis and Control - H. Asada and J.J.E. Slotine John Willey & Sons.
3. Fundamentals of Robotics: Analysis and control, Robert J. Schilling, Prentice Hall,1990.
4. A robot Engineering text book – Mohsen shahinpoor, Harper & RowPublishers,1987
5. Introduction to Robotics: Mechanics and Control, John.J.Craig, Addison- Wesley,1999
6. Robotics: Control, sensing, vision, and intelligence – K.S. FU, R.C. Gonzalezand
7. C.S.G Lee. Mc Graw Hill, 1987.
8. Modeling and control of Robot manipulators, L. sciavicco and b. Siciliano,Springer. 8.ROBOTICS (Fundamental concepts and analysis)ASHITAVA GHOSAL.Oxford university press

Course Code	GEOMETRIC MODELING (PROGRAMME ELECTIVE – II)	L	T	P	C
2015211157		3	0	0	3

Course Objectives:

- To identify types of curve representations methods and implementation of parametric form
- To understand the development of different forms of curves such as four-point form, reparameterization, truncating and subdividing of curves
- To Learn modeling curves (B-splines and Bezier), surface and solids including with their and Familiarity with NURBS Familiarity with advanced techniques such as subdivision and reconstruction
- Mastery of object construction and manipulation methods including Sweep surfaces, surface of revolution, and tabularization.

Course Outcomes:

After the completion of the course, student will be able to

- Use various mathematical equation to represent curves.
- Apply the cubic splines in modeling of a product.
- Select appropriate synthetic curves in modeling process.
- Implement the surface modeling for design of various consumer products.

UNIT – I:

Introduction:

Definition, Explicit and implicit equations, parametric equations.

UNIT – II:

Cubic Splines-1:
Algebraic and geometric form of cubic spline, tangent vectors, parametric space of a curve, blending functions, four-point form, reparameterization, truncating and subdividing of curves. Graphic construction and interpretation, composite pc curves.

UNIT – III:

Bezier Curves:
Bernstein basis, equations of Bezier curves, properties, derivatives.
B-Spline Curves:

B-Spline basis, equations, knot vectors, properties, and derivatives.

UNIT – IV:

Surfaces:

Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, Sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, Gaussian curvature.

UNIT – V:

Solids:

Tri cubic solid, Algebraic and geometric form.

Solid modeling concepts:

Wire frames, Boundary representation, Half space modeling, spatial cell, cell decomposition, classification problem.

Text books:

1. CAD/CAM by Ibrahim Zeid, Tata Mc Graw Hill.
2. Elements of Computer Graphics by Roger & Adams Tata Mc Graw Hill.

References:

1. Geometric Modeling by Micheal E. Mortenson, McGraw Hill Publishers
2. Computer Aided Design and Manufacturing, K. Lalit Narayan, K. Mallikarjuna Rao, MMM Sarcar, PHI Publishers

Course Code	MULTI BODY DYNAMICS (PROGRAMME ELECTIVE – II)	L	T	P	C
2015211158		3	0	0	3

Course Objectives:

- To understand the fundamental of kinematics and dynamics.
- To find the mobility of types of joints under planar conditions.
- To understand the dynamics of planar and spatial systems.
- Inverse and forward dynamic analysis of planar system.

Course Outcomes:

After the completion of the course, student will be able to

- Understand the basic theory of kinematics and dynamics.
- To meet desired needs and solve engineering problems.
- Understand and implement the dynamics of the planar and spatial systems.
- Inverse dynamic analysis and forward dynamic analysis of the planar systems.

UNIT-I:

Review of kinematics and dynamics of point mass and rigid body - types of constraints - constraints for revolute joints, translational joints, composite joints.

UNIT-II:

Formulation of planar multi-body systems, kinematics and dynamics in point coordinates, body coordinates, and joint coordinates.

UNIT-III:

Numerical methods for solution - analysis of planar multi-body systems, kinematic analysis in various formulations.

UNIT-IV:

Inverse dynamic analysis, forward dynamic analysis, constraint stabilization - case studies, McPherson strut suspension, Double A-arm suspension, planar robot manipulator.

UNIT-V:

Spatial multi-body systems-formulation- joints: - revolute, prismatic, cylindrical, spherical, universal-case studies.

Text Books:

1. Planar Multibody Dynamics Formulation, Programming and Applications by Parviz E. Nikravesh, CRC Press
2. Dynamics of Multibody Systems by Ahmed A. Shabana, Cambridge University Press.

Course Code	GEAR ENGINEERING (PROGRAMME ELECTIVE – II) (PSG Design data Book is allowed)	L	T	P	C
2015211159		3	0	0	3

Course Objectives:

- Deduct the concept of fabrication of different types of gears
- Evaluate the various parameters of gear wheel
- Justify the type of gear to be used for the respective application
- Modify the design parameters of a gear wheel for more applications

Course Outcomes:

After the completion of the course, student will be able to

- Organize the gear production processes
- Inspect the gear wheel for its correct profile
- Decide the type of gear used for a particular application
- Propose a correct gear for transmitting the various loads coming on to the gear

UNIT – I:

Introduction: Principles of gear tooth action, Generation of Cycloid and Involute gears, Involutometry, gear manufacturing processes and inspection, gear tooth failure modes, stresses, selection of right kind of gears.

UNIT – II:

Spur Gears, Helical gears, Bevel gears and worm gears, Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of spur gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft and bearings.

UNIT –III:

Gear trains: Simple, compound and epicyclic gear trains, Ray diagrams, Design of a gear box of an automobile, Design of gear trains from the propeller shafts of airplanes for auxiliary systems.

UNIT – IV:

Gear failures

Analysis of gear tooth failures, Nomenclature of gear tooth wear and failure, tooth breakage, pitting, scoring, wear, overloading, gear-casing problems, lubrication failures.

UNIT – V:

Optimal Gear design: Optimization of gear design parameters, Weight minimization, Constraints in gear train design-space, interference, strength, dynamic considerations, rigidity etc. Compact design of

gear trains, multi objective optimization of gear trains. Application of Traditional and non-traditional optimization techniques.

TEXT BOOKS:

1. Maleev and Hartman, Machine Design, C.B.S. Publishers, India.
2. Henry E. Merrit,Gear engineering ,Wheeler publishing,Allahabad,1992.
3. Practical Gear design by Darle W. Dudley, McGraw-Hill book company

REFERENCES:

1. Earle Buckingham, Analytical mechanics of gears, Dover publications, New York, 1949.
2. G. M. Maitha, Hand book of gear design, Tata Mc. Graw Hill publishing company Ltd., New Delhi,1994.

Course Code	MACHINE DYNAMICS LAB	L	T	P	C
2015211110		0	0	4	2

Course Objectives:

- Understand the vibrations and its measurements and its significance on engineering design
- Learn the importance of Static and Dynamic Balancing of machine components
- Know the importance and application of gyroscopic principles
- Impart the knowledge on Direct and Inverse kinematic of a robot

Course Outcomes:

After the completion of the course, student will be able to

- Calculate the damped and undamped natural frequency and amplitude of the vibrating system from experiment
- Test for the balancing of masses in static and dynamic cases
- Evaluate the magnitude of gyroscopic couple, angular velocity of precession
- Explain the Direct and Inverse kinematic of a robot

List of Experiments:

1. Determination of damped natural frequency of the vibrating system with different viscous oils.
2. Determination of steady state amplitude of a forced vibratory system.
3. Determination of natural frequency and mode shape of multi degree freedom system
4. Static balancing of disc
5. Determination of the magnitude and orientation of the balancing mass in dynamic balancing.
6. Field balancing of the thin rotors using vibration pickups.
7. Determination of the magnitude of gyroscopic couple, angular velocity of precession, and representation of vectors.
8. Diagnosis of a machine using FFT analyzer (FFT).
9. Direct kinematic analysis of a robot.
10. Inverse kinematic analysis of a robot.
11. Determination of friction, wear using pin-on-disc.
12. Experimental modal analysis of Beams
    - Estimation of Natural frequency

- Extraction of mode shape
- Estimation of Damping
- Modal Assurance Criteria (MAC) analysis between experimental data and numerical method

13. An experiment on evaluation of stress intensity factor
    - Computation of stresses by mounting 3 axis strain gauges(Rosettes)

Course Code	DESIGN PRACTICE LAB - I	L	T	P	C
2015211111		0	0	4	2

Course Objectives:

- Model the various components using the modelling software's
- Build the geometry of the components
- Analyse the loads coming on the various sections of the component
- Evaluate the loads and various properties of the components

Course Outcomes:

After the completion of the course, student will be able to

- Classify the various types of load applications
- Decide the correct profile of the components
- Create the final dimensions of the components
- Construct the final component in all the parameters

I. Modeling

1. Surface modeling
2. Solid modeling
3. Drafting
4. Assembling

II. Structural Analysis using any FEA Package for different structures that can be discretized with 1-D, 2-D & 3-Delements

1. Static Analysis
2. Modal Analysis
3. Harmonic Analysis
4. Spectrum Analysis
5. Buckling Analysis
6. Analysis of Composites
7. Fracture mechanics

III. Thermal Analysis using any FEA Package for different structures that can be discretized with 1-D, 2-D & 3-Delements

1. Steady state thermal analysis
2. Transient thermal analysis

IV. Transient analysis using any FEA Package for different structures that can be discretized with 1-D, 2-D & 3-Delements

Reference:

User manuals of ANSYS package Version 9.0

Course Code	RESEARCH METHODOLOGY AND IPR	L	T	P	C
2000211100		2	0	0	2

Course Objectives:

- Construct the concept of modern research
- Develop the research ethics
- Design the steps involved in effective technical writing
- Predict the concept of Patents in biological and computer softwares

Course Outcomes:

After the completion of the course, student will be able to

- Develop research methodology
- List the literature study concepts for a particular project
- Determine the concepts of effective technical writing
- Select the Patent procedure

UNIT-I:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT-II:

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT-III:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT-IV:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT-V:

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of

Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students""
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & FrancisLtd,2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992.

Course Code	SOFT SKILLS	L	T	P	C
2000211130		2	0	0	0

Course Objectives:

- To encourage the all-round development of students by focusing on soft skills
- To make the engineering students aware of the importance, the role and the content of soft skills through instruction, knowledge acquisition, demonstration and practice
- To develop and nurture the soft skills of the students through individual and group activities
- To expose students to right attitudinal and behavioral aspects and to build the same through activities

Course Outcomes:

After the completion of the course, student will be able to

- Effectively communicate through verbal/oral communication and improve the listening skills
- Actively participate in group discussion / meetings / interviews and prepare & deliver presentations
- Become more effective individual through goal/target setting, self-motivation and practicing creative thinking
- Function effectively in multi-disciplinary and heterogeneous teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality.

UNIT-I:

Planning and Preparation, Word Order, Breaking up long sentences. Structuring Paragraphs and Sentences, being concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT-II:

Clarifying Who Did What, highlighting your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

UNIT-III:

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT-IV:

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, useful phrases, how to ensure paper is as good as it could possibly be the first-time submission.

UNIT-V:

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

References:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM Highman's book.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London,2011.

I Year II semester

Detailed Syllabus

Course Code	ADVANCED FINITE ELEMENT METHODS	L	T	P	C
2015211200		3	1*	0	3

Course Objectives:

- understand the mathematical and physical principles underlying the Finite Element Method as applied to solid mechanics and thermal analysis
- Know the characteristics of various elements in structural and thermal analysis and selection of suitable elements for the problems being solved
- Impart the knowledge on various field problems and develope the finite element model
- Know the knowledge of FEM for stress analysis, model analysis and solve the engineering problems using commercial finite element packages

Course Outcomes:

After the completion of the course, student will be able to

- Understand the concepts of potential energy, Raleigh Ritz method and weighted residual methods.
- Identify the suitable FEA elements such as bars, truss, beams, constant strain triangle and isoperimetric elements to create Finite Element Model with respect to the application
- Apply suitable boundary conditions to the finite element model and solve the engineering problems
- Solve problems involving dynamics and heat transfer.

UNIT - I

Formulation Techniques: Methodology, Engineering problems and governing differential equations, finite elements. Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

UNIT – II

One-dimensional elements: Bar, trusses, beams and frames, displacements, stresses and temperature effects.

UNIT – III

Two dimensional problems: CST, LST, four noded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two-dimensional fin.

UNIT – IV

Isoperimetric formulation: Concepts, sub parametric, super parametric elements, numerical integration, Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, Pascal's triangle, Patch test.

UNIT – V

Finite elements in Structural Analysis: Static and dynamic analysis, eigen value problems, and their solution methods, case studies using commercial finite element packages.

TEXT BOOK:

1.Finite element methods by Chandrubatla & Belagondu.

REFERENCES:

1. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press,1994
2. Zienckiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill,1983.
3. K. J. Bathe, Finite element procedures, Prentice-Hall,1996

Course Code	ADVANCED MACHINE DESIGN	L	T	P	C
2015211201		3	1*	0	3

Course Objectives:

- To study design concepts in order to enhance the basic design.
- To study behavior of mechanical components under fatigue and creep.
- To study statistical techniques and its applications in mechanical design.
- To understand the design concepts of mechanical components involving contacts avoiding the surface failures.

Course Outcomes:

After the completion of the course, student will be able to

- Design mechanical components by selecting a suitable material and failure criteria.
- Evaluate fatigue life of mechanical components for ductile and brittle materials.
- Analyze and predict the fracture strength of mechanical components under different fracture modes.
- Design mechanical components involving contacts avoiding the surface failures.

UNIT-I

Design philosophy: Design process, Problem formation, Introduction to product design, Various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations -standardization. Creativity and Creative techniques, Material selection in machine design, design for safety and Reliability, concept of product design

UNIT-II

Failure theories: Static failure theories, Distortion energy theory, Maximum shear stress theory, Coulomb-Mohr's theory, Modified Mohr's theory, Fracture mechanics theory., Fatigue mechanisms, Fatigue failure models, Design for fatigue strength and life, creep: Types of stress variation, design for fluctuating stresses, design for limited cycles, multiple stress cycles,

UNIT-III

Fatigue failure theories: cumulative fatigue damage, thermal fatigue and shock, harmful and beneficial residual stresses, Yielding and transformation

UNIT-IV

Surface failures: Surface geometry, mating surfaces, oil film and their effects, design values and procedures, adhesive wear, abrasive wear, corrosion wear, surface fatigue, different contacts, dynamic contact stresses, surface fatigue failures, surface fatigue strength.

UNIT-V

Economic factors influencing design: Economic analysis, Break-even analysis, Human engineering considerations, Ergonomics, Design of controls, Design of displays. Value engineering, Material and process selection in value engineering, Modern approaches in design. Team work and Ethics in engineering design: Team formation, functioning, discharge, team dynamics, Ethical issues considered during engineering design process

TEXT BOOKS:

1. Machine Design an Integrated Approach by Robert L. Norton, Prentice-Hall New Jersey, USA.
2. Mechanical Engineering Design by J.E. Shigley and L.D. Mitchell published by McGrawHill International Book Company, New Delhi.

REFERENCES:

1. Fundamentals of machine elements by Hamrock, Schmid and Jacobian, 2nd edition, McGraw-Hill International edition.
2. Product design and development by Karl T. Ulrich and Steven D. Eppinger. 3rd edition, Tata McGraw Hill.
3. Product Design and Manufacturing by A.K. Chitale and R.C. Gupta, PrenticeHall
4. Engineering Design / George E Dieter / McGraw Hill/2008
5. Fundamentals of machine elements/Hamrock, Schmid and Jacobian/2ndedition /McGrawHill International edition.

Course Code	THEORY OF PLASTICITY (Programme Elective - III)	L	T	P	C
2015211250		3	1*	0	3

Course Objectives:

- Describe the effect of yield point on the plastic behavior.
- Derive the governing equations of plasticity
- Enumerate the principles of plasticity in the design analysis
- Compare various structural behaviors of different sections.

Course Outcomes:

After the completion of the course, student will be able to

- Understand the importance of yield point in the stress analysis.
- Analyze the governing equations of plasticity
- Apply principles of plasticity in the design analysis
- Develop constitutive models based on experimental results on material behavior.

UNIT – I

Introduction: Modeling Uniaxial behavior in plasticity. Index notation, Cartesian tensors. Yield and failure criteria Stress, stress deviator tensors. Invariants, principal, mean stresses. Elastic strain energy. Mohr's representation of stress in 2 & 3 dimensions. Haigh-Westergaard stress space. Equilibrium equations of a body. Yield criteria: Tresca's, von Mises rules, Drucker- Prager criterion, anisotropic yield criteria.

Strain at point: Cauchy's formulae for strains, principal strains, principal shear strains, derivative strain tensor. Strain-displacement relationships. Linear elastic stress strain relations, Generalized Hooke's law, nonlinear elastic stress strain relations

UNIT – II

Principle of virtual work and its rate forms: Drucker's stability postulate, normality, convexity and uniqueness for an elastic solid. Incremental stress strain relations.

Criteria for loading and unloading: Elastic and plastic strain increment tensors, Plastic potential and flow rule associated with different Yield criteria, Convexity, normality and uniqueness considerations for elastic–plastic materials. Expansion of a thick-walled cylinder.

UNIT – III

Incremental stress strain relationships: Prandtl-Reuss material model. J_2 deformation theory, Drucker-Prager material, General Isotropic materials.

Deformation theory of plasticity: Loading surface, Hardening rules. Flow rule and Druckers stability postulate. Concept of effective stress and effective strain, mixed hardening material. Problems.

UNIT – IV

Finite element formulation for an elastic plastic matrix: Numerical algorithms for solving nonlinear equations, Convergence criteria, Numerical implementations of the elastic plastic incremental constitutive relations

UNIT – V

Bounding surface theory: Uniaxial and multiaxial loading anisotropic material behavior Theroms of limit analysis: Statically admissible stress field and kinematically admissible velocity field. Upper and lower bound theorms, examples and problems.

TEXT BOOK:

1. Theory of Elasticity by S.P. Timoshenko & J.K Goodier, MGH

REFERENCES:

1. Plasticity for structural engineering W.F.Chen s and D.J.Han, Springerverlag-1987.
2. Mechanics of Materials –II, Victor E.Saouma.
3. Theory of plasticity, SadhuSingh

Course Code	Signal Analysis and Condition Monitoring (Programme Elective - III)	L	T	P	C
2015211251		3	1*	0	3

Course Objectives:

- Basic concepts: Fourier analysis, Bandwidth. Signal, Convolution.
- Practical analysis of stationary signals.
- Practical analysis of continuous non-stationary signals.
- Condition monitoring in real systems.

Course Outcomes:

After the completion of the course, student will be able to

- Understand basic concepts of Fourier analysis, Bandwidth. Signal, and Convolution.
- Analysis of stationary signals.
- Analysis of continuous non-stationary signals.
- Apply condition monitoring in real systems.

UNIT-I

Introduction, Basic concepts. Fourier analysis. Bandwidth. Signal types. Convolution.
Signal analysis: Filter response time. Detectors. Recorders. Analog analyzer types.

UNIT-II

ANALYSIS OF STATIONARY SIGNALS: Stepped filter analysis. Swept filter analysis. High speed analysis. Real-time analysis.

UNIT-III

ANALYSIS OF CONTINUOUS NON-STATIONARY SIGNALS: Choice of window type. Choice of window length. Choice of incremental step. Practical details. Scaling of the results.

UNIT-IV

ANALYSIS OF TRANSIENTS: Analysis as a periodic signal. Analysis by repeated playback (constant bandwidth). Analysis by repeated playback (variable bandwidth).

UNIT-V

CONDITION MONITORING IN REAL SYSTEMS: Diagnostic tools. Condition monitoring of two stage compressor. Cement mill foundation. I.D. fan. Sugar centrifugal. Cooling tower fan. Air separator. Preheater fan. Field balancing of rotors. ISO standards on vibrations, active, passive hybrid methods of condition monitoring

TEST BOOK:

1. Condition Monitoring of Mechanical Systems /Colcote.

REFERENCES:

1. Frequency Analysis/R. B. Randall.
2. Mechanical Vibrations Practice with Basic Theory / V. Ramamurti/ NarosaPublishing House.
3. Theory of Machines and Mechanisms/ Amitabh Ghosh& AK Malik/EWP

Course Code	Computational Fluid Dynamics (Programme Elective - III)	L	T	P	C
2015211252		3	1*	0	3

Course Objectives:

- To understand the continuum mechanics theory.
- To solve the continuum mechanics problem using Eulerian and Lagrangian description.
- To understand the mass conservation and energy conversion laws of continuum mechanics
- To use the continuum mechanics theories in elastic materials, viscous fluids, linear visco-elasticity.

Course Outcomes:

After the completion of the course, student will be able to

- Understant the continuum mechanics.
- Generate the concept of new product and different fabrication process.
- Make the solid model in virtual platform and evaluate the product using computer software.
- Selecting the correct process of fabrication to optimze the cost and quality.

UNIT – I

Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations.

Solution methods: Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination.

Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

UNIT – II

Hyperbolic equations: explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations.

Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

UNIT – III

Formulations of incompressible viscous flows: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

Formulations of compressible flows: potential equation, Eluer equations, Navier-stokes system of equations, flowfield-dependent variation methods, boundary conditions, example problems.

UNIT – IV

Finite volume method: Finite volume method via finite difference method, formulations for two and three-dimensional problems.

UNIT – V

Standard variational methods: Linear fluid flow problems, steady state problems, Transient problems.

TEXT BOOK:

1. Computational fluid dynamics, T. J. Chung, Cambridge University press, 2002.

REFERENCE:

1. Text book of fluid dynamics, Frank Chorlton, CBS Publishers &distributors, 1985.

Course Code	COMPOSITE MATERIALS (Programme Elective - III)	L	T	P	C
2015211253		3	1*	0	3

Course Objectives:

- Understand the concept of composite materials
- Distinguish the types of composite materials
- Modify the matrix-reinforcement composition according to the application
- Solve the properties of composite materials

Course Outcomes:

After the completion of the course, student will be able to

- Understand the importance of composite materials
- Distinguish various materials used for matrix and reinforcement
- Recommend the composite material according to the application
- Modify the material according to the types of loads coming on to specimen

UNIT I

Introduction: History and basic concept of composites. Definition and Classification of Composites, MMC, PMC, CMC. Reinforcing fibres- Natural fibres (cellulose, jute, coir etc), boron, carbon, ceramic glass, aramids, polyethylene (UHMWPE), polybenzthiazoles etc.

UNIT II

Fundamental concepts:
Particulate fillers-importance of particle shape and size. Matrix resins-thermoplastics and thermosetting matrix resins. Coupling agents-surface treatment of fillers and fibres, significance of interface in composites. Nanocomposites, short and continuous fibre reinforced composites, critical fibre length, and anisotropic behaviour.

UNIT III

Fabrication techniques: pultrusion, filament winding, prepreg technology, injection and compression moulding, bag moulding, resin transfer moulding, reaction injection moulding.

UNIT IV

Properties and performance of composites: Properties and microstructure of high-strength fiber materials (glass, carbon, polymer, ceramic fibers) and matrix materials (polymer, metal, ceramic, and carbon matrices). Specific strength and stiffness of high-performance composites. Rule ofmixtures. Stress, straintransformations.

UNIT V

Failure criteria: Hygrothermal stresses, bending of composite plates, analysis of sandwich plates, buckling analysis of laminated composite plates, inter-laminar stresses, First Order Shear Deformation Theory (FSDT). Applications: Industrial, aerospace, automobile, house hold etc.

TEXT BOOKS:

1. Steven L. Donaldson, ASM Handbook Composites Volume 21,2001.
2. Krishan K. Chawla, Composite Materials, Science and Engineering, Springer,2001.
3. Suresh G. Advani, E. Murat Sozer, Process Modelling in Composites Manufacturing, 2ndEd. CRC Press,2009

Course Code	CONTINUUM MECHANICS (PROGRAMME ELECTIVE - III)	L	T	P	C
2015211254		3	1*	0	3

Course Objectives:

- To understand the continuum mechanics theory.
- To solve the continuum mechanics problem using Eulerian and Lagrangian description.
- To understand the mass conservation and energy conversion laws of continuum mechanics
- To use the continuum mechanics theories in elastic materials, viscous fluids, linear visco-elasticity.

Course Outcomes:

After the completion of the course, student will be able to

- Understand the continuum mechanics.
- Solve the continuum mechanics problem using Eulerian and Lagrangian description.
- Use the laws of continuum mechanics for mass conservation and energy conversion.
- Use the continuum mechanics theories for Elastic Materials, Viscous fluids, linear visco-elasticity.

UNIT - I

Tensor calculus: Tensor calculus, Multi linear forms, Definition of Tensor over including vector spaces, Alternating tensors, determinants, orientation, tensor products, kinematics of deformations and motion, strain analysis, rotation of tensors, calculations of tensors, internal calculations of tensors and integral identities.

UNIT – II

Eulerian and Lagrangian description of a continuous, discrete systems, continua, physical quantities and their derivatives. Rigid body motion, Relation between continuum models and real materials.

UNIT – III

Conservation laws in a continuum: Mass conservation in Lagrangen and Eulerian frames, Conservation of momentum in Lagrangen and Eulerian frames.

UNIT – IV

Conservation in angular momentum in lagrengian form. Conservation of energy in in Lagrangen and Eulerian frames.Strain and decomposition. Finite deformation, infinitesimal displacements

UNIT – V

Material frame indifference, Elastic Materials, Viscous fluids, linear visco-elasticity, case studies for metals and polymers.

TEXT BOOK

1. Continuous mechanics, George Backus, Samizdat Press, 1997

REFERENCES:

1. Mechanics of Continua, A.C. Eringan, 1962
2. Continuous Physics, Vol. 1, A.C. Eringan, 1967, Academic press
3.Introduction to Continuous Mechanics, B.L.N. Kennett
4. Quick introduction to Tensor analysis, R.Sharipov, 2004, Samizdat Press.
5. Non-linear continuum mech-win, SEACAS theory manuals part II, T. A. Laursen, S.W. Attaway and R.I.Zadoks

Course Code	EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS (Programme Elective - IV)	L	T	P	C
2015211255		3	0	0	3

Course Objectives:

- Acquire a core understanding of probability and inferential statistics
- Carry out a variety of statistical tests on different types of data
- Analyse independently-collected data to answer a research question
- Learn the common pitfalls and misconceptions in carrying out inferential statistical analyses

Course Outcomes:

After the completion of the course, student will be able to

- Clean and manipulate raw data sets so they are ready for analysis
- Determine and carry out the appropriate statistical test for a variety of experimental questions about different data sets
- Draw conclusions about whether research hypotheses have been supported by empirical data.
- Plan the statistical analysis of an independent research project

UNIT-I

Measurement of cutting forces: Strain gauge and piezoelectric transducers and their characteristics. Dynamometer construction, Bridge circuits. Instrumentation and calibration. Displacement and Strain measurements by photoelasticity, Holography, interferometer, Moir techniques, strain gauge rosettes.

UNIT-II

Temperature Measurement: Circuits and instrumentation for different transducers viz., bimetallic, expanding fluid, electrical resistance, thermister, thermocouples,pyrometers.
Flow Measurement: Transducers for flow measurements of Non-compressible fluids, Obstruction and drag methods. Vortex shredding flow meters. Ultrasonic, Laser Dopler and Hotwire anemometer. Flow visualization techniques, Shadow graphs, Schilieren photography. Interferometer.

UNIT-III

Metallurgical Studies: Optical and electron microscopy, X-ray diffraction, Bragg‟s Law and its application for studying crystal structure and residual stresses. Electron spectroscopy, electron microprobe.
Surface Measurement: Micro hardness, roughness, accuracy of dimensions and forms. 3-D Co-ordinate measuring machines.

UNIT-IV

Experiment design & data analysis: Statistical methods, Randomised block design, Latin and orthogonal squares, factorial design. Replication and randomization.

Data Analysis: Deterministic and random data, uncertainty analysis, test of significance: Chi-square, student‟s „t‟ test. Regression modeling, direct and interaction effects. ANOVA, F-test. Time Series analysis, Autocorrelation and autoregressive modeling.

UNIT-V

Taguchi Methods: Experimental design and planning with Orthogonal arrays and linear graphs. Additive cause-effect model, Optimization of response level. Identification of Design and noise factors. Performance evaluation and Optimization by signal to noise ratios. Concepts of loss function and its application.

TEXT BOOKS:

1. Jack Philip Holman, Experimental Methods for Engineers, 7th edition, McGraw-Hill,2001
2. V. C. Venkatesh, H. Chandrasekaran, Experimental Techniques in Metal Cutting, Eastern economy edition, Prentice-Hall of India,1987

REFERENCES:

1. George E. P. Box, Gwilym M. Jenkins, Gregory C. Reinsel, Greta M. Ljung, Time Series Analysis: Forecasting and Control, 5th Edition, John Wiley & Sons,2015
2. Richard C. Dove, Paul H. Adams, Experimental stress analysis and motion measurement: theory, instruments and circuits, techniques, C. E. Merrill Books,1964
3. BagchiTapan P, Taguchi Methods Explained: Practical Steps to Robust Design, Prentice-Hall (India),1993.

Course Code	DESIGN WITH ADVANCED MATERIALS (Programme Elective - IV)	L	T	P	C
2015211256		3	0	0	3

Course Objectives:

- Know the elasticity in metals, mechancisms such as solid solution and dispersion strengthening, and stress-strain rate on plastic behaviour
- Select the material based on cost, service, and various mechanical properties such as toughness, fatigue, impact and creep.
- Understand the properties of modern metallic materials such as dual phase steels, intermetallics, and other super alloys.
- Understand the processing and properties of polymer based composite materials, smart materials, shape memory alloys, and some refractory materials

Course Outcomes:

After the completion of the course, student will be able to

- Understand the concepts such as elasticity in materials, plastic deformation, and advanced concepts like solid solution and dispersion strengthening.
- Select the material based on cost, service, and mechanical properties using material property charts
- Analyze material characteristics of various modern metallic materials such as sual phase steels, intermetallics, and alloys.
- Evaluate the porcessing and properties of polymer based compsoite materials, smart materials, shape memory alloys.

UNIT – I

Fundamentals of material science: Elasticity in metals and polymers, mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening.
Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity, deformation of non crystalline material.

UNIT – II

Motivation of selection, cost basis and service requirements, selection for mechanical properties, strength, toughness, fatigue and creep, use of material property charts for material selection.

UNIT – III

Modern metallic Materials: Dual phase steels, micro alloyed, high strength low alloy (HSLA) Steel, maraging steel, intermetalics, Ni and Ti aluminides, super alloys.

UNIT – IV

Non metallic materials: Polymeric materials and their molecular structures, production techniques for fibers, foams, adhesives and coatings, structure, properties and applications of engineering polymers. composites; Introduction, reinforcement, types of composite materials, - properties, processing and application of compositematerials.

UNIT – V

Smart materials, shape memory alloys, metallic glass, quasi crystal and nano crystalline materials.

TEXT BOOKS:

1. Mechanical behavior of materials/Thomas H.Courtney/2nd Edition, McGraw-Hill,2000
2. Mechanical Metallurgy/George E.Dieter/McGraw Hill,1998
3. Material selction in mechanical design by M.F Ashby.Bott

REFERENCES:

1. Selection and use of Engineering Materials 3e/Charles J.A/ButterworthHeiremann.

Course Code	DESIGN SYNTHESIS (Programme Elective - IV)	L	T	P	C
2015211257		3	0	0	3

Course Objectives:

- Learn a variety of approaches modes and tools of analysis and synthesis that generate deep insights and innovative solutions
- Know different design approaches for machining operations.
- Learn modular constructions erection, operation inspection and maintenance considerations
- Learn the design optimization technique

Course Outcomes:

After the completion of the course, student will be able to

- Describe the role of analysis and synthesis in the design process
- Understand Tolerance from process and function
- Describe the design methods for forging, assembly and dismantling process
- Develop problems formulation for design optimization

UNIT – I

Design process and methodologies of systematic design conceptual design variants and evaluation; Standardization and its exploitation in design.

UNIT – II

Tolerance from process and function; interchangeability and selective assembly; selection of fits for different design situations, surface finish. Load transmission, load equalization light weigh and rigid constructions.

UNIT – III

Design of cast forged sheet metal parts and welded constructions Machining considerations.

UNIT – IV

Design for assembly and dismantling; Modular constructions erection, operation inspection and maintenance considerations; Ergonomics Design of accuracy; Location pins and registers, Machining in assembly, adjustment, Backlash and Clearance adjustment.

UNIT – V

Problems formulation for design optimization Example illustration the various principles available

design variants for some of the common basic functional requirements.

TEXT BOOK:

1. Engineering Design a material and processing approach/ George Dieter/ McGraw Hi8 ll international book company 1983

REFERENCES:

1. Engineering Design a systematic approach/ G. Phal W. Beitz/ Springer /3rd Edition
2. Mechanical Design Theory Methodology/ Manjula B. Waldron and Kenneth J. Waldron/ Springer Verlag New York 1996.

Course Code	TRIBOLOGY (Programme Elective - IV)	L	T	P	C
2015211258		3	0	0	3

Course Objectives:

- To provide the knowledge and importance of Tribology in Design, friction, wear and lubrication aspects of machine components
- To select proper grade lubricant for specific application.
- To understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques.
- To provide the knowledge about different seals

Course Outcomes:

After the completion of the course, student will be able to

- Illustrate the fundamentals of tribology and the tribological parameters of all classes of materials.
- Explain about various Lubrication Techniques
- Demonstrate about bearing properties and analyze about bearing failure
- Classify different types of seals and its uses

UNIT – I

Introduction: Nature of surfaces and contact-Surface topography-friction and wear mechanisms, wear maps, effect of lubricants- methods of fluid film formation.
Lubrication: Choice of lubricants, types of oil, Grease and solid lubricants- additives-lubrication systems and their selection.

UNIT – II

Selection of rolling element bearings: Nominal life, static and dynamic capacity-Equivalent load, probabilities of survival- cubic mean load- bearing mounting details, pre loading of bearings, conditioning monitoring using shock pulse method.

UNIT – III

Hydrostatic Bearings: Thrust bearings – pad coefficients- restriction- optimum film thickness-journal bearings – design procedure –Aerostatic bearings; Thrust bearings and Journal bearings – design procedure.

UNIT – IV

Hydrodynamic bearings: Fundamentals of fluid formation – Reynold's equation; Hydrodynamic journal bearings – Sommerfield number- performance parameters – optimum bearing with maximum load capacity – Friction – Heat generated and Heat dissipated. Hydrodynamic thrust bearings; Raimondi and Boyd solution for hydrodynamic thrust bearings-fixed tilting pads, single and multiple pad bearings-optimum condition with largest minimum

film thickness.

UNIT – V

Seals: different type-mechanical seals, lip seals, packed glands, soft piston seals, Mechanical piston rod packing, labyrinth seals and throttling bushes, oil flinger rings and drain grooves – selection of mechanical seals.
Failure of Tribological components: Failure analysis of plain bearings, rolling bearings, gears and seals, wear analysis using soap and Ferrography.
Dry rubbing Bearings: porous metal bearings and oscillatory journal bearings – qualitative approach only.

TEXT BOOKS:

1. .RoweWW&O"Dionoghue,"HydrostaticandHybridbearingdesign"Butterworths&Co.P ublishersLtd,1983.
2. Collacott R.A," Mechanical Fault diagnosis and condition monitoring", Chapman andHall, London1977.
3. Bernard J.Hamrock, " Fundamentals of fluid film lubricant", McGraw-HillCo.,1994.

REFERENCES:

1. Neale MJ, (Editor) " Tribology hand Book"NeumannButterworths,1975.
2. Connor and Boyd JJO (Editors) " Standard hand book of lubrication engineers "ASLE,Mc Graw Hill Book &Co.,1968
3. Shigley J, E Charles," Mechanical Engineering Design", McGraw Hill Co.,1989

Course Code	EXPERIEMNTAL MODAL ANALYSIS (Programme Elective - IV)	L	T	P	C
2015211259		3	0	0	3

Course Objectives:

- Overview of modal analysis: Vibrations of single and multiple degree of freedom.
- Frequency response functions measurement
- Inverse Method – Residuals – MDOF curve-fitting procedures – MDOF curve fitting
- Applications of Model correlation. Concepts of modal assurance criterion.

Course Outcomes:

After the completion of the course, student will be able to

- Understand different modal analysis: Vibrations of single and multiple degree of freedom.
- Analyze Frequency response functions measurement.
- Understand Inverse Method, Residuals MDOF, curve-fitting procedures.
- Apply Model correlation and modal assurance criterion for variants.

UNIT I

Theoretical basis for modal analysis:
Overview of modal analysis, Vibrations of single and multiple degree of freedom (SDOF, MDOF) systems, Frequency response functions (FRFs) for SDOF/MDOF systems. Types of FRFs. Orthogonality of modes and their application in modal analysis, Theory of undamped, proportionally damped, and non-proportionally damped SDOF/MDOF systems, Analyses for complex modes and sensitivity analysis of modal models.

UNIT II

FRF measurement considerations:
Introduction to test planning, Excitation of structures (electromagnetic and electrohydraulic shakers, hammers, etc.), Transducers and amplifiers for measurements (force transducer, accelerometers, laser vibrometers, signal conditioners, amplifiers etc.), Actuator/sensor placement considerations, Revision of Fourier analysis and Fourier transforms, Discussions on aliasing, leakage, windowing, filtering and averaging, Role of excitations signals in structural testing.

UNIT III

Modal Parameter Extraction Methods: Introduction – Preliminary checks of FRF Data – SDOF Modal Analysis-I – Peak-amplitude – SDOF Modal Analysis-II – Circle Fit Method – SDOF Modal Analysis III.

UNIT IV

Inverse Method – Residuals – MDOF curve-fitting procedures – MDOF curve fitting in the Time Domain – Global or Multi-Curve fitting – Non linear systems.

UNIT V

Applications and advanced topics: Model correlation. Concepts of modal assurance criterion and some of its variants, Dynamic sub structuring, Modal reduction and expansion, Model updating, Advanced curve fitting for modal parameter extractions, Testing of weakly nonlinear structures.

TEXT BOOKS

1. W T Thomson., " Theory of Vibrations with Applications", CBS Publishers
2. S S Rao, " Mechanical Vibrations", Addison-Wesley Publishing Co.

REFERENCES

3. Leonard Meirovitch, " Fundamentals of Vibration", McGraw Hill International Edison.
4. J P Den Hartog, "Mechanical Vibrations", Mc GrawHill.
5. Srinivasan, " Mechanical Vibration Analysis", Mc GrawHill.
6. Nuno Manuel Mendes Maia et al," Theoretical and Experimental Modal Analysis", Wiley John & sons,1999
7. Modal Analysis, by Jimin He and Zhi-Fang Fu,Butterworth-Heinemann

Course Code	COMPUTATIONAL MATHEMATICS LAB	L	T	P	C
2015211210		0	0	4	2

Course Objectives:

- MATLAB and Python code for solving a system of linear equationusing using Gauss Elimination Method.
- MATLAB and Python code for Iterative methods to solve equations using Jacob iteration.
- MATLAB and Python code for Matrices and Eigenvalues
- MATLAB and Python code for Partial Differential equations

Course Outcomes:

After the completion of the course, student will be able to

- Apply MATLAB and Python code for solving a system of linear equation using Gauss Elimination Method.
- Apply MATLAB and Python code for Iterative methods to solve equations using Jacob iteration.
- Apply MATLAB and Python code for Matrices and Eigenvalues
- Apply MATLAB and Python code for Partial Differential equations

1. Generate a MATLAB and Python code for solving a system of linear equation using Gauss Elimination Method.
2. Generate a MATLAB and Python code for LU Decomposition (Factorization)
3. Generate a MATLAB and Python code for Iterative methods to solve equations using Jacob iteration.
4. Generate a MATLAB and Python code for Curve fitting
    i. Straight line fit
    ii. Polynomial Curve fit
5. Generate a MATLAB and Python code for Fourier transformation
    i. FFT Vs DFT
    ii. Interpolation by DFS
6. Generate a MATLAB and Python code for Euler's method differential equations
7. Generate a MATLAB and Python code for Runge – Kutta method differential equations
8. Generate a MATLAB and Python code for Matrices and Eigenvalues
    i. Eigen values and Eigenvectors
    ii. Jacobi method
9. Generate a MATLAB and Python code for Partial Differential equations

i. Elliptical PDE
ii. Parabolic PDE
iii. The Crank – Nicholson method
iv. Two dimensional parabolic PDE

Course Code	DESIGN PRACTICE LAB – II	L	T	P	C
2015211211		0	0	4	2

Course Objectives:

- Model the various components using the modelling softwares
- Build the geometry of the components
- Analyze the loads coming on the various sections of the component
- Evaluate the loads and various properties of the components

Course Outcomes:

After the completion of the course, student will be able to

- Classify the various types of load applications
- Decide the correct profile of the components
- Create the final dimensions of the components
- Construct the final component in all the parameters

OBJECTIVES:

To know the method of programming the microprocessor and pneumatic experiments in basic electrical, hydraulic & pneumatic Systems which enable the students to understand the concept.

LIST OF EXPERIMENTS:

Part: A- MECHATRONICS

1) Simulation of basic Hydraulic, Pneumatic and Electric circuits using software.
2) Testing of circuits using basic pneumatic trainer kits.
3) Tircuits with logic sequence using Electro pneumatic trainer kit.
4) Tequential circuits in Electro pneumatic kit using PLC.
5) Testing of fluid power circuits to control (i) Velocity (ii) direction and(iii) force of single and double acting actuators.
6) Study of sequential and hydraulic motor circuit using hydraulic systems.
7) Servo controller interfacing for open loop.
8) Servo controller interfacing for closed loop.
9) PID controller interfacing.
10) Stepper motor interfacing with 8051 Microcontroller.
    (i) Full step resolution (ii) half step resolution

Part: B – Material Characterization

1) Microscopy: Different microscopy techniques, Resolution, Magnification, Depth of

field Imaging – theory and concepts.

2) Optical Microscopy: Grain size estimation, Phase Percentage Estimation
3) XRD- Estimation of Crystal planes, Crystal size, phase analysis, etc.
4) X-ray microanalysis: EDS, EPMA (Surface analysis)
5) XRD, EBSD, SEM (Applications to crystallography)
6) X-ray methods (EDS, XRF)
7) Spectroscopy (IR, Raman)
8) FTIR, UV Visible Spectrophotometer
9) Sputtering, PVD/CVD Coatings
10) Testing of Materials- Micro hardness, Tensile strength, Flexural strength, Wear, Abrasion.

Subject code	CONSTITUTION OF INDIA	L	T	P	C
2000191230		2	0	0	0

Course Objectives:

- To Enable the student to understand the importance of constitution and understand the structure of executive, legislature and judiciary
- To understand philosophy of fundamental rights and duties
- To understand the autonomous nature of constitutional bodies like Supreme Court and high court controller and auditor general of India and election commission of India.
- To understand the central and state relation financial and administrative

Course Outcomes:

After the completion of the course, student will be able to

- Have general knowledge and legal literacy and thereby to take up competitive examinations.
- Understand state and central policies, fundamental duties.
- Understand Electoral Process, special provisions.
- Understand powers and functions of Municipalities, Panchayats and Cooperative Societies

Unit-I:

Introduction to Indian Constitution: Constitution' meaning of the term, Indian Constitution - constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties

UNIT II:

Union Government and its Administration Structure of the Indian Union. President: Role, power and position, PM and Council of ministers, LokSabha, RajyaSabha, The Supreme Court and High Court: Powers and Functions

Unit-III:

State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organization, Structure and Functions

Unit-IV:

A.Local Administration - District's Administration Head - Role and Importance, Municipalities - Mayor and role - CEO of Municipal Corporation PachayatiRaj: Functions

ZilaPanchayat, CEO ZilaPanchayat

Unit-V:

Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission.

Text Books:

1. Civics, Telugu Academy

References:

1. Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd.. New Delhi
2. SubashKashyap, Indian Constitution, National Book Trust
3. J.A. Siwach, Dynamics of Indian Government & Politics
4. D.C. Gupta, Indian Government and Politics
5. H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
6. J.C. Johari, Indian Government andPolitics Hans
7. J. Raj IndianGovernment and Politics
8. M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice – Hall of India Pvt. Ltd.. New Delhi
9. Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right), Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

Subject code		L	T	P	C
2015211270	MINI PROJECT WITH SEMINAR	0	0	4	2

For Mini Project with Seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Project Review Committee (PRC) consisting of Head of the Department, supervisor/mentor and two othersenior faculty members of the department. For Mini Project with Seminar, there **will be only internal evaluation** of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

Mini project report is evaluated for 100 marks.

a) Assessment by the supervisor /guide for 30 marks
b) Assessment by PRC for 40 marks (20 marks x 2 reviews)
c) Seminar presentations for 30 marks (department level committee assessment)

II Year I Semester
Detailed Syllabus

Course Code	INDUSTRIAL ROBOTICS (Programme Elective-V)	L	T	P	C
2015212150		3	1*	0	3

Course Objectives:

- understand robot structure and configuration
- model a given manipulator kinematically and dynamically
- program a given robot for performing a task
- analyze the industrial applications of different kinds of robots and design their work cells

Course Outcomes:

After the completion of the course, student will be able to

- Summarize robot components, configurations and different end effectors
- Formulate the kinematics and dynamics of a manipulator
- Write a program to manipulate the end effector of a robot to move along a specified path
- Select a robot for a given industrial application and design its cell layout

UNIT -I

INTRODUCTION: Automation and Robotics, Robot anatomy, robot configuration, motions joint notation scheme, work volume, robot drive systems, control Systems and dynamic performance, precision of movement.

CONTROL SYSTEM AND COMPONENTS: basic concepts and motion controllers, control system analysis, robot actuation and feedback components.

SENSORS: Desirable features, tactile, proximity and range sensors, uses sensors in robotics. Positions sensors, velocity sensors, actuators, power transmission systems

UNIT -II

MOTION ANALYSIS AND CONTROL: Manipulator kinematics, position representation, forward and inverse transformations, homogeneous transformations, manipulator path control, robot arm dynamics, configuration of a robot controller. Robot joint control design.

UNIT -III

END EFFECTORS: Grippers-types, operation, mechanism, force analysis, tools and effector consideration in grippers election and design.

MACHINEVISION: Functions, Sensing and Digitizing-imaging devices, Lighting techniques, Analog to digital single conversion, image storage: Image processing and Analysis-image data reduction, Segmentation, feature extraction, Object recognition.

Training the vision system, Robotic application.

UNIT -IV

ROBOT PROGRAMMING: Lead through programming, Robot program as a path in space, Motion interpolation, WAIT, SIGNAL ANDDELAY commands, Branching, capabilities and Limitations of lead through methods.
ROBOTLANGUAGES: Textual robot Languages, Generations of robot programming languages, Robot language structures, Elements and function.

UNIT -V

ROBOT CELL DESGIN AND CONTROL: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work design, Work and control, Inter locks, Error detection, Work cell controller.

ROBOT APPLICATION: Material transfer, Machine loading/unloading, Processing operation, Assembly and Inspection, Future Application.

TEXT BOOKS:

1. Industrial Robotics / Groover M P /Pearson Edu.
2. Introduction to Robotic Mechanics and Control by JJ Craig, Pearson, 3rd edition.

REFERENCES:

1 Robotics / Fu K S/ McGraw Hill.
2 Robotic Engineering/ Richard D. Klafter, Prentice Hall
3 Robot Analysis and Intelligence/ Asada and Slotine / Wiley Inter-Science.
4 Robot Dynamics &Control– Mark W. Spong and M. Vidyasagar / John Wiley
5 Introduction to Robotics by SK Saha, The McGrahHill Company, 6th, 2012
6 Robotics and Control / Mittal R K & Nagrath IJ/TMH

Course Code	ADVANCED OPTIMIZATION TECHNIQUES (Programme Elective -V)	L	T	P	C
2015212151		3	1*	0	3

Course Objectives:

- To Enumerate the fundamental knowledge of Linear Programming and Dynamic Programming problems.
- To Learn classical optimization techniques and numerical methods of optimization.
- To Know the basics of different evolutionary algorithms.
- To implement Multi objective optimization techniques and apply different optimization techniques to solve various models arising from engineering areas

Course Outcomes:

After the completion of the course, student will be able to

- Explain the fundamental knowledge of Linear Programming and Dynamic Programming problems
- Use classical optimization techniques and numerical methods of optimization
- Describe the basics of different evolutionary algorithms
- Enumerate fundamentals of Integer programming technique and apply different techniques to solve various optimization problems arising from engineering areas

UNIT -I

Classical optimization techniques: Single variable optimization with and without constraints, multi–variable optimization without constraints, multi–variable optimization with constraints– Method of Lagrange multipliers, Kuhn-Tucker conditions.

UNIT -II

Numerical methods for optimization: Nelder Mead Simple search method, Gradient of a function, Steepest descent method, Newton method, types of penalty methods for handling constraints.

UNIT -III

Genetic algorithm (GA): Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and cross over operators, GA for constrained optimization, drawbacks of GA,

Multi-Objective GA: Pareto analysis, non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems

UNIT – IV

Genetic Programming (GP): Principles of genetic programming, terminal sets, functional

sets, differences between GA & GP, random population generation, solving differential equations using GP.

UNIT V

Applications of Optimization in Design and Manufacturing systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam and general optimization model of a machining process.

TEXT BOOKS:

1. Optimal design – Jasbir Arora, Mc Graw Hill (International)Publishers
2. Optimization for Engineering Design– Kalyanmoy Deb, PHI Publishers
3. Engineering Optimization– S.S.Rao, New Age Publishers

REFERENCES:

1.Genetic algorithms in Search, Optimization, and Machine learning–D.E. Goldberg, Addison-Wesley Publishers
2. Genetic Programming-Koza
3. Multi objective Genetic algorithms-Kalyanmoy Deb, PHI Publishers

Course Code	ADDITIVE MANUFACTURING (Programme Elective- V)	L	T	P	C
2015212152		3	1	0	3

Course Objectives:

- To familiar with the additive manufacturing process and its evolution
- Selection of various additive manufacturing processes based on application
- To apply the knowledge of additive manufacturing to Rapid prototyping
- To apply the knowledge of additive manufacturing to Rapid tooling

Course Outcomes:

After the completion of the course, student will be able to

- Recognize the development of Additive Manufacturing technology and opportunities for transforming a concept into product development.
- Apply the suitable rapid prototyping process for a given product
- Apply the suitable rapid tooling process for a given product
- Explore the applications of AM processes

UNIT I

Additive Manufacturing Process: Basic Principles of the Additive Manufacturing Process, Generation of Layer Information, Physical Principles for Layer Generation. Elements for Generating the Physical Layer, Classification of Additive Manufacturing Processes, Evaluation of the Theoretical Potentials of Rapid Prototyping Processes.

UNIT II

Machines for Rapid Prototyping: Overview of Polymerization: Stereolithography (SL), Sintering/Selective Sintering: Melting in the Powder Bed, Layer Laminate Manufacturing (LLM) and Three-Dimensional Printing(3DP).

UNIT III

Rapid Prototyping**:** Classification and Definition, Strategic Aspects for the Use of Prototypes, Applications of Rapid Prototyping in Industrial Product Development.
Rapid Tooling**:** Classification and Definition of Terms, Properties of Additive Manufactured Tools.

UNIT IV

Indirect Rapid Tooling Processes: Molding Processes and Follow-up Processes, Indirect Methods for the Manufacture of Tools for Plastic Components, Indirect Methods for the Manufacture of Metal Components.

UNIT V

Direct Rapid Tooling Processes: Prototype Tooling: Tools Based on Plastic Rapid Prototyping Models and Methods, Metal Tools Based on Multilevel AM Processes, Direct Tooling: Tools Based on Metal Rapid Prototype Processes.

TEXT BOOKS:

1. Andreas Gebhardt Jan-Steffen Hotter, Additive Manufacturing: 3D Printing for Prototyping and Manufacturing, Hanser Publications, 6915 Valley Avenue, Cincinnati, Ohio.
2. Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies: 3DPrinting, Rapid Prototyping, and Direct Digital Manufacturing, Second Edition, Springer New York Heidelberg Dordrecht London.

REFERENCES:

1. LiouL. W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
2. Kamrani A. K. and Nasr E. A., "Rapid Prototyping: Theoryandpractice",Springer,2006. 3. Hilton P.D. and Jacobs P.F., "Rapid
3. Tooling: Technologies and Industrial Applications", CRC press, 2000.

Course Code	MECHANICS OF COMPOSITE MATERIALS (Programme Elective -V)	L	T	P	C
2015212153		3	1	0	3

Course Objectives:

- Understand the concept of composite materials
- Distinguish the types of composite materials
- Modify the matrix-reinforcement composition according to the application
- Solve the properties of composite materials

Course Outcomes:

After the completion of the course, student will be able to

- Understand the importance of composite materials
- Distinguish various materials used for matrix and reinforcement
- Recommend the composite material according to the application
- Modify the material according to the types of loads coming on to specimen

UNIT-I

Introduction to Composites, Classification, matrix materials, reinforced matrix of composites.

UNIT-II

Hooke‟sLawforaTwo-DimensionalAngleLamina,EngineeringConstantsofanAngleLamina,InvariantFormofStiffness andComplianceMatricesforanAngleLaminaStrengthFailureTheoriesofanAngleLamina:Maximum StressFailureTheoryStrengthRatio,FailureEnvelopes,MaximumStrainFailureTheory,Tsai–HillFailureTheory,Tsai–WuFailureTheory, Comparison of Experimental Results with FailureTheories.HygrothermalStressesandStrainingLamina:HygrothermalStress strainRelationshipsforaUnidirectionalLamina,HygrothermalStress–StrainRelationships for an Angle Lamina

UNIT-III

Macro mechanical Analysis of a Lamina: Introduction, Definitions: Stress, Strain, Elastic Moduli, and Strain Energy. Hooke's Law for Different Types of Materials, Hooke's Law for a Two-Dimensional Unidirectional Lamina, Plane Stress Assumption, Reduction of Hooke's Lawin Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina,

UNIT-IV

Micro mechanical Analysis of a Lamina: Introduction, Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Module, Strength of Materials Approach,

Semi-Empirical Modeli, Elasticity Approach, Elastic of Lamina with Transversely Isotropic Fibers, Ultimate Strengths of a Unidirectional Lamina, Coefficients of Thermal Expansion, Coefficients of Moisture Expansion

Micromechanical Analysis of Laminates: Introduction, Laminate Code, Stress–Strain Relations for a Laminate, In-Plane and Flexural Modulis of a Laminate, Hygro thermal Effects in a Laminate, Warpage of Laminates, hybrid laminates

UNIT-V

Failure, Analysis, an design of Laminates: Introduction, Special Case of Laminates, Failure Criterion for a Laminate, Design of a Laminated Composite, static analysis of laminated plates

TEXT BOOKS:

1. Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.
2. B. D. Agarwal and L.J. Broutman, Analysis and performance of fibre Composites, Wiley-Interscience, New York, 1980.
3. Mechanics of Composite Materials, Second Edition (Mechanical Engineering), by Autar K. Kaw, Publisher: CRC

REFERENCES:

1.R. M. Jones, Mechanics of Composite Materials, McGrawHill Company, NewYork,1975.
2. L. R. Calcote, Analysis of Laminated Composite Structures, Van Nostr and Rainfold, NewYork, 1969.

Course Code	PRESSURE VESSEL DESIGN (Programme Elective-V)	L	T	P	C
2015212154		3	1	0	3

Course Objectives:

- To familiar students with the selection of material for pressure vessels
- To compute the mechanical and thermal stresses in pressure vessels
- To familiar with the design processes of thick rectangular and circular plates
- To predict the fatigue life of thick pressure vessels

Course Outcomes:

After the completion of the course, student will be able to

- To identify different materials of pressure vessels and select the materials based on application
- Design dome bends, shell connections, flat heads and cone openings.
- Analyze the discontinuity stresses in vessels.
- Evaluate the stress theory of failure of vessels subject to steady state and fatigue conditions.

UNIT-I

Introduction: Materials-shapes of Vessels-stresses in cylindrical, spherical and arbitrary, shaped shells. Cylindrical Vessels subjected to internal pressure, wind load, bending and torque for computation of pressure vessels-conical and tetrahedral vessels.

UNIT – II

Theory of thick cylinders: Shrink fit stresses in built up cylinders-auto frettage of thick cylinders. Thermal stresses in Pressure Vessels.

UNIT – III

Theory of rectangular plates: Pure bending-different edge conditions.

Theory circular plates: Simple supported and clamped ends subjected to concentrated and uniformly distributed loads-stresses from local loads. Design of dome bends, shell connections, flat heads and cone openings.

UNIT – IV

Discontinuity stresses in pressure vessels: Introduction, beam on an elastic foundation, infinitely long beam, semi-infinite beam, cylindrical vessel under axially symmetrical loading, extent and significance of load deformations on pressure vessels, discontinuity stresses in vessels, stresses in a bimetallic joints, deformation and stresses in flanges.

UNIT – V

Pressure vessel materials and their environment: Introduction, ductile material tensile tests, structure and strength of steel, Leuder's lines, determination of stress patterns from plastic flow observations, behaviour of steel beyond the yield point, effect of cold work or strain hardening on the physical properties of pressure vessel steels, fracture types in tension, toughness of materials, effect of neutron irradiation of steels, fatigue of metals, fatigue crack growth, fatigue life prediction, cumulative fatigue damage, stress theory of failure of vessels subject to steady state and fatigue conditions.

TEXT BOOKS:

Theory and design of modern Pressure Vessels by John F.Harvey, Van nostrand reihold company, New York.

Pressure Vessel Design and Analysis by Bickell, M.B.Ruizcs.

REFERENCES:

Process Equipment design- Beowll & Yound Ett.

Indian standard code for unfired Pressure vessels IS:2825.

Pressure Vessel Design Hand Book, Henry H.Bednar, P.E., C.B.S.Publishers, New Delhi.

Theory of plates and shells- Timoshenko & Noinosky.

II Year – I & II Semester

(PROJECT)
PHASE – I & PHASE - II

Every candidate shall be required to submit Project on a topic approved by the Project Review Committee (PRC).

Continuous assessment of **Project Phase – I** and **Project Phase –II** during the semester(s) will be monitored by the PRC.

Project Phase – I:

Project Phase – I/Industrial project: In Project Phase - I, literature review, design calculations and a prototype model are to be prepared within 16 weeks.

In case of Industrial project, students have to complete coursework related to the particular semester through MOOCs

The evaluation of Project Phase -I/Industrial project will be purely internal for **100 marks** based on the presentation of literature review, design calculations and demonstration of prototype model.

Project Phase – II:

In **Project Phase – II**, experimentation, analysis (analytically or using modern software tools), results & discussion and conclusions are to be prepared and submitted.

A candidate shall submit his status report after each review. Minimum three reviews at PRC level shall be conducted in a gap of one month each for both Project Phase – I & II.

Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the external examiner who adjudicated the Thesis. The Board shall jointly evaluate the candidate's work for a maximum of **100 marks.**