ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, RAJAMPET
(AN AUTONOMOUS INSTITUTION)

Affiliated To
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR, ANANTAPUR.

ACADAMIC REGULATIONS

COURSE STRUCTURE

AND DETAILED SYLLABI

MASTER OF TECHNOLOGY

MACHINE DESIGN

M.Tech Regular Two Year P.G. Degree Course
Applicable for students admitted from 2017 - 18

ACADEMIC REGULATIONS

Applicable for students admitted into M.Tech. Programme from 2017-18

The Jawaharlal Nehru Technological University Anantapur shall confer M.Tech. Post graduate degree to candidates who are admitted to the Master of Technology Programmes and fulfill all the requirements for the award of the degree.

1. ELIGIBILITY FOR ADMISSIONS:

Admission to the above programme shall be made subject to the eligibility, qualifications and specialization prescribed by the competent authority for each programme, from time to time.

Admissions shall be made either on the basis of merit rank obtained by the qualifying candidates at an Entrance Test conducted by the University or on the basis of GATE/PGECET score, subject to reservations or policies framed by the Government of Andhra Pradesh policies from time to time.

2. ADMISSION PROCEDURE:

As per the existing stipulations of AP State Council for Higher Education (APSCHE), Government of Andhra Pradesh, admissions are made into the first year as follows

a) Category-A seats are to be filled by Convenor through PGECET/GATE score.

b) Category-B seats are to be filled by Management as per the norms stipulated by Government of A. P.

3. SPECIALIZATION:

The following specializations are offered at present for the M.Tech. programme.

Sl. No.	**Specialization**
1.	CAD/CAM
2	Machine Design
2.	Digital Electronics and Communication Systems
3.	Embedded Systems
4.	VLSI System Design
5.	Computer Science and Engineering
6.	Electrical Power Engineering
7.	Electrical Power Systems
8	Structural Engineering

and any other specialization as approved by the concerned authorities from time to time.

4. COURSE WORK:

4.1. A Candidate after securing admission must pursue the M. Tech. programme of study for four semesters duration.

4.2. Each semester shall be of 20 weeks duration including all examinations.

4.3. A candidate admitted in to the programme should complete it within a period equal to twice the prescribed duration of the programme from the date of admission.

5. ATTENDANCE

5.1. A candidate shall be deemed to have eligibility to write end semester examinations if he has put in at least 75% of attendance aggregate in all subjects/courses in the semester.

5.2. Condonation of shortage of attendance up to 10% i.e., between 65% and above and less than 75% may be granted by the Institute Academic committee.

5.3. Shortage of attendance below 65% in aggregate shall in no case be condoned.

5.4. Condonation of shortage of attendance shall be granted only on genuine and valid reasons on representation by the candidate with supporting evidence.

5.5. A stipulated fee shall be payable towards condonation of shortage of attendance to the institute as per following slab system

1st Slab: Less than 75% attendance but equal to or greater than 70% a normal condonation fee can be collected from the student.

2nd Slab: Less than 70% but equal to or greater than 65%, double the condonation fee can be collected from the student.

5.6. Students whose shortage of attendance is not condoned in any semester are not eligible to take their end examination of that class and their registration shall stand cancelled for that semester.

5.7. A student will not be promoted to the next semester unless he satisfies the attendance requirements of the current semester, as applicable.

5.8. A student detained due to shortage of attendance, will have to repeat that semester when offered next.

6. CREDIT SYSTEM NORMS:

	Period(s)/week	**Credits**
Theory	01	01
Practical	03	02
Seminar	01	01
Project	-	16

TABLE 1

7. EVALUATION:

7.1 Distribution of marks

S. No	Examination	Marks	Examination and Evaluation	Scheme of Evaluation
1.	Theory	60	Semester-end examination (External evaluation)	The question paper shall be of descriptive type with 5 questions with internal choice are to be answered in 3hours duration of the examination.
		40	Mid - Examination of 120 Min. duration (Internal evaluation). 4 descriptive type questions with internal choice are to be answered and evaluated for 30 marks, and the reaming 10 marks are to be allotted for 3-5 assignments to be submitted by the student. The assignment marks are to be awarded based on the completeness of the assignment, correctness of the assignment and in-time submission, evaluated for 10 marks and average of the total assignment marks are rounded to the next integer.	Two mid-exams 30 marks each are to be conducted. Better one to be considered. **Mid-I:** After first spell of instructions (I&II Units). **Mid-II:** After second spell of instructions (III - V Units).
2	Laboratory	60	Semester-end Lab Examination (External evaluation)	**For laboratory courses: 3** hours duration. One External and One Internal examiners.

S. No	Examination	Marks	Examination and Evaluation		Scheme of Evaluation
		40	30	Day to Day evaluation (Internal evaluation)	Performance in laboratory experiments.
			10	Internal evaluation	Practical Tests (one best out of two tests includes viva-voce)
3	Seminar in each of the semesters. 2 hours /week	100	Internal Evaluation 20 Marks for Report 20 Marks for subject content 40 Marks for presentation 20 Marks for Question and Answers		Continuous evaluation during a semester by the Departmental Committee (DC)
4	Project work	Grade A (95%) Grade B (85%)	12 credits	External evaluation	End Project Viva-Voce Examination by Committee as detailed under sect. 9.
			4 credits	Internal evaluation	Continuous evaluation by the DC. as detailed under sect. 9.5

7.2 A candidate shall be deemed to have secured the minimum academic requirement in a subject/practical if he secures a minimum of 40% of marks in the End Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Evaluation taken together.

7.3 A candidate has to secure a minimum of 50% to be declared successful.

7.4 In case the candidate does not secure the minimum academic requirement in any of the subjects/practical, he has to reappear for the Examination either supplementary or regular in that subject/practical along with the next batch students. A separate supplementary examinations will be conducted for the I semester students at the end of II semester.

7.5 **Revaluation / Recounting:** Students shall be permitted to request for recounting/ revaluation of the end theory examination answer

scripts within a stipulated period after payment of prescribed fee. After recounting or revaluation, records are updated with changes if any and the student will be issued a revised memorandum of marks. If there are no changes, the student shall be intimated the same through a letter or a notice.

8. RE-REGISTRATION FOR IMPROVEMENT OF INTERNAL EVALUATION MARKS(for theory subjects only):

8.1 Out of the subjects the candidate has failed in the examination due to internal evaluation marks secured being less than 50%, the candidate shall be given one chance for each theory subject and for a maximum of **Three** theory subjects for improvement of internal evaluation marks.

8.2 The candidate can re-register for the chosen subjects and fulfill the academic requirements. Re-registration shall not be permitted after the commencement of class work for that semester. The candidate can re-register for 1st semester subjects when he is in his 3rd semester and for 2nd semester subjects when he is in his 4th semester else the candidate can re-register after completion of 2 years course work.

8.3 For each subject re-registered, the candidate has to pay a fee equivalent to one third of the semester tuition fee.

8.4 In the event of re-registration, the internal evaluation marks as well as the End Examinations marks secured in the previous attempt(s) for those subjects stand cancelled.

9. EVALUATION OF PROJECT WORK:

Every candidate shall be required to submit thesis/dissertation after taking up a topic approved by the Departmental Committee.

9.1 The Departmental Committee (DC) consisting of HOD, Project supervisor and two internal senior experts shall monitor the progress of the project work. A Project Review Committee (PRC) shall be constituted with Principal as Chair Person, Heads of the departments of the M.Tech Programs and Two other senior faculty members, as members of the PRC. PRC will come into action when the DC is not able to resolve the issues.

9.2 Registration of Project work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the courses (theory, practical and seminar of I & II semesters).

9.3 After satisfying 9.2, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work to the DC for approval. Only after obtaining the approval of DC, the student can initiate the project work.

9.4 The work on the project shall be initiated in the penultimate semester and continued in the final semester. The duration of the project is for two semesters. The candidate can submit Project thesis with the approval of DC after 36 weeks from the date of registration at the earliest but not later than one calendar year from the date of registration for the project work. Extension of time within the total permissible limit for completing the programme is to be obtained from the Head of the Institution.

9.5 The Internal Evaluation shall be made by the DC to grade, on the basis of two seminars presented by the student on the topic of his project.

9.6 The student must submit status report at least in two different phases during the project work period. These reports must be approved by the DC before submission of the Project Report.

9.7 A candidate shall be allowed to submit the thesis / dissertation only after passing all the prescribed subjects (theory, practical and seminar).

9.8 A candidate has to prepare four copies of the thesis/dissertation certified in the prescribed format by the supervisor and HOD. Out of which three copies shall be submitted in the examination section.

9.9 Viva-voce examination shall be conducted by a board consisting of the supervisor, Head of the department and the examiner. The board shall jointly report candidate's work as.

A Very Good performance
B Moderate Performance
C Failure Performance

Head of the Department shall coordinate and make arrangements for the conduct of viva-voce.

If the report of the viva-voce is failure performance, the candidate will retake the viva-voce examination after three months. If he fails to get a satisfactory report at the second viva-voce examination, he will not be eligible for the award of the degree.

10. CREDIT POINT AVERAGE AND CUMULATIVE CREDIT POINT AVERAGE:

10.1. CREDIT POINT AVERAGE (CPA):

$$\textbf{CPA} = \frac{\sum_i C_i T_i}{10\sum_i C_i}$$

Where C_i= Credits earned for Course i in any semester/year.

T_i= Total marks obtained for course i in any semester/year.

10.2. CUMULATIVE CREDIT POINT AVERAGE (CCPA):

$$\textbf{CCPA} = \frac{\sum_n \sum_i C_{ni} T_{ni}}{10\sum_n \sum_i C_{ni}}$$

Where ***n*** refers to the semester in which such courses were credited.

The CCPA is awarded only when a student earns all the credits prescribed for the programme.

10.3. OVERALL PERFORMANCE:

CCPA	Classification of Final Results
7.0 and above	First Class with Distinction
6.0 and above but below 7.0	First Class
5.0 and above but below 6.0	Second Class

11. TRANSCRIPTS:

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

12. ELIGIBILITY:

A student shall be eligible for the award of M.Tech Degree if he fulfills all the following conditions:

i. Registered and successfully completed all the components prescribed in the programme of study to which he was admitted.
ii. Successfully acquired all **72 credits** as specified in the curriculum corresponding to the branch of his study within the stipulated time.
iii. No disciplinary action is pending against him.

13. AWARD OF DEGREE:

The Degree will be conferred and awarded by Jawaharlal Nehru Technological University Anantapur, Anantapur on the recommendations of the Principal, AITS (Autonomous) based on the eligibility as mentioned in clause 11.

14. WITHHOLDING OF RESULTS:

If the candidate has any dues to the Institute or if any case of in-discipline is pending against him, the result of the candidate shall be withheld and he will not be allowed / promoted into the next higher semester. The issue of degree is liable to be withheld in such cases.

15. TRANSITORY REGULATIONS:

Candidates who have discontinued or have been detained for want of attendance or who have failed after having undergone the course in earlier regulations and wish to continue the course are eligible for admission into the unfinished semester from the date of commencement of class work with the same or equivalent subjects as and when subjects are offered. Whereas, he continues to be in the academic regulations he was first admitted.

16. AMENDMENTS OF REGULATIONS:

The Chairman, Academic Council of Annamacharya Institute of Technology and Sciences, Rajampet (Autonomous) reserves the right to revise, amend, or change the Regulations, Scheme of Examinations and/or Syllabi or any other policy relevant to the needs of the society or industrial requirements etc., without prior notice.

17. GENERAL:

Where the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.

18. Any legal issues are to be resolved in Rajampet Jurisdiction.

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Annamacharya Institute of Technology and Sciences, Rajampet.							
Curriculum for the Programmes under Autonomous Scheme							
Regulation	R 2017						
Department	Department of Mechanical Engineering						
Programme Code & Name	PF: M.Tech. Machine Design						
Semester I							
Course Code	Course Name	Hours/ Week		Credit	Maximum marks		
		L	P	C	Internal	External	Total
7PEC14	Computational Methods	4	0	4	40	60	100
7PF511	Advanced Mechanisms	4	0	4	40	60	100
7PF512	Advanced Mechanics of Solids	4	0	4	40	60	100
7PF513	Fracture Mechanics	4	0	4	40	60	100
7PF514	Materials Technology	4	0	4	40	60	100
7PF515 7PF516 7PF517	Elective - I Tribology Gear Engineering Non-Destructive Evaluation	4	0	4	40	60	100
7PF518	Seminar – I	0	0	2	100	00	100
7PF519	Modeling and Analysis Laboratory	0	3	4	40	60	100
Total		24	3	30	800		
Semester II							
Course Code	Course Name	Hours/ Week		Credit	Maximum marks		
		L	P	C	Internal	External	Total
7PE521	Advanced Optimization Techniques	4	0	4	40	60	100
7PE522	Robotics	4	0	4	40	60	100
7PF521	Mechanical Vibrations	4	0	4	40	60	100
7PF522	Mechanics of Composite Materials	4	0	4	40	60	100
7PF523	Theory of Plasticity	4	0	4	40	60	100
7PF524 7PF525 7PF526	Elective - II Design for Manufacturing Design of Material Handling Equipment Pressure Vessel Design	4	0	4	40	60	100
7PF527	Seminar – II	0	0	2	100	00	100
7PF528	Machine Dynamics Laboratory	0	3	4	40	60	100
Total		24	3	30	800		
Semester III & IV							
Course Code	Course Name	Credit		Maximum Marks			
		C		Internal	External	Total	
7PF531	Project	16		40	60	100	

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M. Tech. I Semester (MACHINE DESIGN)

(7PF511) ADVANCED MECHANISMS

UNIT-I Introduction: Element of mechanisms; Mobility criterion for planar mechanisms and manipulators; Mobility criterion for spatial mechanisms and manipulators. Spherical mechanisms- Spherical trigonometry.
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.

UNIT – II Advanced Kinematics of plane motion – II: Polode curvature, Hall's Equation, Polode curvature in the four bar mechanism, coupler 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.

UNIT – III Introduction to Synthesis – Analytical Methods: Types of synthesis, dimensional synthesis-motion generation, path generation, Function generation – Freudenstien's equation, chebychev's spacing of points, bloch's synthesis, synthesis of four bar mechanism by inversion method(clockwise rotation- two position synthesis).

UNIT – IV: Graphical Synthesis - Motion generation: The Four bar linkage, Guiding a body through Two distinct positions, Guiding a body through Three distinct positions, The Rotocenter triangle, Guiding a body through Four distinct positions, Burmester's curve.
Function generation- Relative – Rotocenter method, Velocity – Pole method concept of Overlay's method.

UNIT – V: Manipulator Kinematics: Denavit - Hartenberg convention of assignment of co-ordinate frames and link parameters table, Denavit - Hartenberg transformation matrix, Direct and inverse kinematic analysis of Serial manipulators, Articulated, spherical & industrial robot manipulators – PUMA, SCARA, STANFORD ARM.

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.*

REFERANCE BOOKS:

1. *Alten 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. *Mohsen Shahinpoor, A Robot Engineering Text book, Harper & Row Publishers, New York, 1987.*
4. *Joseph Duffy, Analysis of mechanisms and Robot manipulators, Edward Arnold, 1980.*

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M. Tech. I Semester (MACHINE DESIGN)

(7PF512) ADVANCED MECHANISCS OF SOLIDS

UNIT –I Shear center: Bending axis and shear center-shear center for axi-symmetric and unsymmetrical sections
Unsymmetrical bending: Bending stresses in Beams subjected to Non-symmetrical bending; Deflection of straight beams due to non-symmetrical bending.

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

UNIT – III Two Dimensional Elasticity Problems: Plane stress & Plain strain-Problems in Rectangular Co-ordinates, bending of cantilever loaded at the end, bending of a beam by uniform load.
In polar co-ordinators, general equations in polar coordinates, stress distribution symmetrical about an axis, pure bending of curved bars, displacements for symmetrical stress distributions, rotating discs.

UNIT – IV Introduction to Three Dimensional Problems: Uniform stress stretching of a prismatical bar by its own weight, twist of circular shafts of constant cross section, pure bending of plates.

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;
Axi-Symmetric Problems: Rotating Discs- Flat discs, Discs of uniform thickness, Discs of uniform strength; Rotating Cylinders

TEXT BOOKS:

1. Strength of Materials by Sadhu Singh.
2. Strength of Materials & Theory of Structures (Vol I & II) by B.C. Punmia.
3. Advanced Mechanics of Materials by Boresi & Sidebottom – Wiley International .

REFERENCES:

1. Advanced Strength of Materials by Den Hortog J.P
2. Theory of Plates – Timoshenko
3. Theory of elasticity by Timoschenko S.P. and Goodier J.N. McGraw-Hill Publishers 3/e.

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M. Tech. I Semester (MACHINE DESIGN)

(7PF513) FRACTURE MECHANICS

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, Fatigue for composites, Experimental methods for G_I and G_{II}.

UNIT-III

The effect of Constraint: definition of plane stress and plane strain and the effect of component thickness. The plasticity at the crack tip and the principles behind the approximate derivation of plastic zone shape and size, Limits on the applicability of LEFM.

Elastic-Plastic Fracture Mechanics (EPFM): Examples of major fracture failures in the history, Definition of alternative failure prediction parameters, Crack Tip Opening Displacement, and the J integral, Measurement of parameters and examples of use, Fracture failure for thick plates by using EPFM.

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. G. E. Dieter, Mechanical Metallurgy, McGraw Hill, (1988)
3. Machine Design by Shigley.

REFERENCES:

1. B. Lawn, Fracture of Brittle Solids, Cambridge Solid State Science Series 2nd ed1993.
2. J.F. Knott, Fundamentals of Fracture Mechanics, Butterworths (1973)
3. J.F. Knott, P Withey, Worked examples in Fracture Mechanics, Institute of Materials.
4. H.L.Ewald and R.J.H. Wanhill Fracture Mechanics, Edward Arnold, (1984).
5. S. Suresh, Fatigue of Materials, Cambridge University Press, (1998)
6. L.B. Freund and S. Suresh, Thin Film Materials Cambridge University Press,(2003).
7. D.C. Stouffer and L.T. Dame, Inelastic Deformation of Metals, Wiley (1996)
8. F.R.N. Nabarro, H.L. deVilliers, The Physics of Creep, Taylor and Francis, (1995)

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M. Tech. I Semester (MACHINE DESIGN)

(7PF514) MATERIALS TECHNOLOGY

Unit – I

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, Iron-Iron carbon system.

Unit – II

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.

Selection of Material: Motivation of selection, cost basis and service requirements based selection.

Unit – III

Modern metallic Materials: Dual phase steels, micro alloyed, high strength low alloy (HSLA) Steel, transformation induced plasticity (TRIP) Steel, maraging steel, intermetalics, Ni and Ti aluminides, structure and properties of white cast iron.

Unit – IV

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

Non metallic materials: Polymeric materials and their molecular structures, production techniques for fibers, foams, adhesives and coatings, structure, properties and applications of engineering polymers.

Unit – V

Advanced structural ceramics WC, TiC, TaC, Al_2O_3, SiC, Si_3 N_4, CBN and diamond-properties, processing and applications.

Advance structural composites; Introduction, reinforcement, types of composite materials, - properties, processing and application, and mechanics of composite 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 Science and Metullargy/Kodgire.

REFERENCES:

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

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M. Tech. I Semester (MACHINE DESIGN)

(7PF515) TRIBOLOGY
(ELECTIVE-I)

UNIT I

SURFACE INTERACTION AND FRICTION: Topography of Surfaces – Surface features-Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction –Rolling Friction-Friction properties of metallic and non-metallic materials – friction in extreme conditions –Thermal considerations in sliding contact

UNIT II

WEAR AND SURFACE TREATMENT: Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models- Wear of Metals and Non metals – Surface treatments – Surface modifications – surface coatings methods–Laser methods – International standards in friction and wear measurements.

UNIT III

LUBRICANTS AND LUBRICATION REGIMES: Lubricants and their physical properties- Viscosity and other properties of oils –Additives-and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication-Dry and marginally lubricated contacts- Boundary Lubrication Hydrodynamic lubrication – Hydro static lubrication- Gas lubrication.

UNIT IV

THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION:
Reynolds Equation,-Assumptions and limitations-One and two dimensional Reynolds Equation- Reynolds and Sommerfeld boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing-

UNIT V

HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION: Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical contacts-Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory- Soft and hard EHL-Reynolds equation for elasto hydrodynamic lubrication- - Film shape within and outside contact zones- Film thickness and friction calculation- Rolling bearings- Stresses and deflections-Traction drives.

TEXT BOOKS:

1. Rabinowicz.E, "Friction and Wear of materials", John Willey &Sons, UK, 1995.
2. Cameron, A. "Basic Lubrication Theory", Ellis Herward Ltd., UK, 1981
3. Halling, J. (Editor) – "Principles of Tribology ", Macmillian – 1984.
4. Williams J.A., "Engineering Tribology", Oxford Univ. Press, 1994.
5. S.K.Basu, S.N.Sengupta & B.B.Ahuja, "Fundamentals of Tribology", Prentice – Hall of India Pvt Ltd , New Delhi, 2005
6. G.W.Stachowiak & A.W .Batchelor, Engineering Tribology, Butterworth-Heinemann,UK, 20053. *Shigley J, E Charles," Mechanical Engineering Design", McGraw Hill Co.,* 1989.

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M. Tech. I Semester (MACHINE DESIGN)

(7PF516) GEAR ENGINEERING
(ELECTIVE-I)
(Design data Book to be used and allowed in Examinations)

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

UNIT – II Spur Gears: Principles of Geometry, Force Analysis, Design considerations and methodology, Complete design of spur gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load.
Helical Gears: Principles of Geometry, Force Analysis, Design considerations and methodology, Complete design of helical gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load.

UNIT – III Bevel Gears: Principles of Geometry, Force Analysis, Design considerations and methodology, Complete design of bevel gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load.
Worm Gears: Principles of Geometry, Force Analysis, Design considerations and methodology, complete design of worm gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Heat dissipation considerations.

UNIT – IV Gear trains: Simple, compound and machine tool gear box design, Ray diagrams, Design of a gear box of an automobile, Design of gear trains for the propeller shafts of airplanes for auxiliary systems.

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. *Practical Gear design by Darle W. Dudley, McGraw-Hill book company.*
3. Machine Design by T.V.Sundararajamoorthy,N.Shanmugam,Anuradha Publications.
4. Machine Design by Hall, Holowenko,Laughlin, McGraw-Hill book company.
5. V.B.Bhandari, *Machine Design, 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.*
3. *Henry E.Merrit,Gear engineering ,Wheeler publishing,Allahabad,1992*.

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M. Tech. I Semester (MACHINE DESIGN)

(7PF517) NON-DESTRUCTIVE EVALUATION (ELECTIVE-I)

UNIT – I Ultra Sonic Hardness Testing: Flaw Detection Using Dye Penetrants. Magnetic Particle Inspection introduction to electrical impedance, Principles of Eddy Current testing, Flaw detection using eddy currents.

UNIT – II Introduction to 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.

UNIT-III X-Ray Radiography processes: 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 – IV Introduction to Ultrasonic Testing: 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,
Ultrasonic tests: 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 – V Holography: Principles and practices of Optical holography, acoustical, microwave, x-ray and electron beam holography techniques.
Applications - I: NDT in flaw analysis of Pressure vessels, piping
Applications - II: 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*.

ANNAMACHARYA INSTITUTE OF TECHNOLOGY & SCIENCES::RAJAMPET
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M. Tech. II Semester (MACHINE DESIGN)

(7PE521) ADVANCED OPTIMIZATION TECHNIQUES

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 Linear programming: Two-phase simplex method, Big-M method, duality, interpretation, applications**Assignment problem**: Hungarian's algorithm, applications, unbalanced problems, traveling salesman problem.

UNIT – III Numerical methods for optimization: Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, types of penalty methods for handling constraints.

UNIT – IV Genetic algorithm (GA) : Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA.

Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

Multi-Objective GA: Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems .
Particle Swarm Optimization technique, Ant Colony Search technique.

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, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

Text Books:

1. Engineering Optimization, S.S.Rao, New Age Publishers.
2. Optimal design, Jasbir Arora, Mc Graw Hill (International) Publishers.
3. Multi objective Genetic algorithms, Kalyanmoy Deb, PHI Publishers.
4. Genetic Programming, John R Koza, The MIT Press.

References:

1. Optimization for Engineering Design, Kalyanmoy Deb, PHI Publishers. algorithms in Search, Optimization, and Machine learning, D.E.Goldberg, Genetic
2. Hamdy A.Taha "Operations Research" Prentice Hall of India.

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M. Tech. II Semester (MACHINE DESIGN)

(7PE522) ROBOTICS

Unit – I

Fundamentals of Robots: Introduction, definition of robot, Laws of robots, classification of robots, History of robotics, robot components, degree of freedom, robot joints, robot coordinates, reference frames, robot characteristics, robot work space, advantages, disadvantages and applications of robots.

Matrix transformations: Introduction, robots as a mechanisms, 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.

Unit – II

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.

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

Unit – IV

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.

Robot Actuators: Introduction, characteristics of Actuating systems-weight, power to weight ratio, operating pressure, stiffness Vs compliance, types of actuators used in robots, comparison of actuating systems, hydraulic devices, pneumatic devices, Electric motors-DC motorcar motors, Brushless DC motors, direct Drive electric motors, servomotors, stepped motors, types of micro controllers used in robots.

Unit – V

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. Introduction to image processing.

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,Nicholas G.Odrey – Mc Graw Hill, 1986

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M. Tech. II Semester (MACHINE DESIGN)

(7PF521) MECHANICAL VIBRATIONS

Unit I

Single degree of Freedom systems: Undamped and damped free vibrations: forced vibrations; coulomb damping; Bifilar suspension; Response to harmonic excitation; rotating unbalance and support excitation; Vibration isolation and transmissibility, Response to arbitrary excitations.

Unit II

Vibration measuring instruments: Vibrometers, velocity meters & accelerometers.

Two degree freedom systems: Principal modes – undamped and damped free and forced vibrations; undamped vibration absorbers;

Unit III

Multi degree freedom systems: Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion;

Unit IV

Torsional vibrations of single rotor, multi – rotor and geared systems; Discrete-Time systems, Stodolas method, Matrix iteration, Rayleigh Ritz method and Dunkerly's method.

Unit V

Critical speeds of shafts: Critical speeds without and with damping, secondary critical speed.

Continuous systems: Free vibration of strings – longitudinal oscillations of bars-traverse vibrations of beams- Torsional vibrations of shafts.

Text books:

1. Mechanical Vibrations by G.K. Groover.
2. Vibrations by W.T. Thomson

References:

1. Elements of Vibration Analysis by Meirovitch.
2. Mechanical Vibrations – Schaum series.
3. Vibration problems in Engineering by S.P. Timoshenko.
4. Mechanical Viabrations – V.Ram Murthy.

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M. Tech. II Semester (MACHINE DESIGN)

(7PF522) MECHANICS OF COMPOSITE MATERIALS

UNIT-I

Introduction to Composite Materials: Introduction ,Classification: Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Carbon–Carbon Composites, Fiber- Reinforced Composites and nature-made composites, and applications .

Reinforcements: Fibres- Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosets, Metal matrix and ceramic composites.

UNIT-II

Manufacturing methods: Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion, RTM.

Macromechanical Analysis of a Lamina :Introduction ,Definitions: Stress, Strain ,Elastic Moduli,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 Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina.

UNIT-III

Hooke's Law for a Two-Dimensional Angle Lamina, Engineering Constants of an Angle Lamina, Strength Failure Theories of an Angle Lamina , Comparison of Experimental Results with Failure Theories. Hygro-thermal Stresses and Strains in a Lamina: Hygro-thermal Stress–Strain Relationships for a Unidirectional Lamina, Hygro-thermal Stress–Strain Relationships for an Angle Lamina

UNIT-IV

Micromechanical Analysis of a Lamina :Introduction, Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Moduli, Strength of Materials Approach, Semi- Empirical Models ,Elasticity Approach, Elastic Moduli of Lamina with Transversely Isotropic Fibers, Ultimate Strengths of a Unidirectional Lamina, Coefficients of Thermal Expansion, Coefficients of Moisture Expansion.

UNIT-V

Macromechanical Analysis of Laminates: Introduction , Laminate Code , Stress–Strain Relations for a Laminate, In-Plane and Flexural Modulus of a Laminate , Hygrothermal Effects in a Laminate, Warpage of Laminates

Failure, Analysis, and Design of Laminates : Introduction , Special Cases of Laminates, Failure Criterion for a Laminate, Design of a Laminated Composite, Other Mechanical Design Issues.

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, Mc Graw Hill Company, New York, 1975.
2. L. R. Calcote, Analysis of Laminated Composite Structures, Van Nostrand Rainfold, New York, 1969.

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M. Tech. II Semester (MACHINE DESIGN)

(7PF523) THEORY OF PLASTICITY

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. J2 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 non linear 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 books/References:

1. Plasticity for structural engineering W.F.Chen s and D.J.Han, Springer verlag-1987.
2. Mechanics of Materials –II, Victor E. Saouma

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M. Tech. II Semester (MACHINE DESIGN)

(7PF524) DESIGN FOR MANUFACTURING
(Elective-II)

UNIT I:
INTRODUCTION: Design philosophy steps in Design process - General Design rules for manufacturability - basic principles of design Ling for economical production - creativity in design. Materials: Selection of Materials for design Developments in Material technology - criteria for material selection - Material selection interrelationship with process selection process selection charts.

UNIT II:
MACHINING PROCESS: 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 tolerances - use of solidification simulation in casting design - product design rules for sand casting.

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:
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.
PLASTICS: Visco elastic and creep behavior in plastics-design guidelines for plastic components-design considerations for injection moulding – design guidelines for machining and joining of plastics.

TEXT BOOKS:

1. Engineering design-Material and Processing Approach, George E. Deiter, Mc. Graw Hill Intl. 2nd Ed.2000.
2. Product design for Manufacture and Assembly, Geoffrey Boothroyd,Marcel Dekker Inc. NY, 1994.

REFERENCE BOOKS:

1. Product design and Manufacturing, A.K Chitale and R.C Gupta, Prentice,Hall of India, New Delhi, 2003.
2. Design and Manufacturing ,Surender Kumar &GouthamSutradhar, Oxford & IBH Publishing Co. Pvt .Ltd., New Delhi, 1998.
3. Hand Book of Product Design, Geoffrey Boothroyd Marcel Dekken Inc. NY, 1990.
4. Product Design, Kevin Otto and Kristin Wood, Pearson Education.

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M. Tech. II Semester (MACHINE DESIGN)

(7PF525) DESIGN OF MATERIAL HANDLING EQUIPMENT

UNIT I

MATERIALS HANDLING EQUIPMENT: Types, selection and applications.

UNIT II

DESIGN OF HOISTS: Design of hoisting elements: Welded and roller chains - Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs - lifting magnets - Grabbing attachments - Design of arresting gear - Brakes: shoe, band and cone types.

UNIT III

DRIVES OF HOISTING GEAR: Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.

UNIT IV

CONVEYORS: Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.

UNIT V

ELEVATORS: Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counter weights, hoisting machine, safety devices - Design of fork lift trucks.

REFERENCES

1. Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970.
2. Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.

3. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
4. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
5. P.S.G. Tech., “Design Data Book”, Kalaikathir Achchagam, Coimbatore, 2003.
6. Lingaiah. K. and Narayana Iyengar, “Machine Design Data Hand Book”, Vol.1 & 2, Suma Publishers, Bangalore, 1983

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M. Tech. II Semester (MACHINE DESIGN)

(7PF526) PRESSURE VESSEL DESIGN
(Elective II)

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-ilation 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:

1. Theory and design of modern Pressure Vessels by John F.Harvey, Van nostrand reihold company, New York.
2. Pressure Vessel Design and Analysis by Bickell, M.B.Ruizcs.

REFERENCES:

1. Process Equipment design- Beowll & Yound Ett.
2. Indian standard code for unfired Pressure vessels IS:2825.
3. Pressure Vessel Design Hand Book, Henry H.Bednar, P.E., C.B.S.Publishers, New Delhi.
4. Theory of plates and shells- Timoshenko & Noinosky.

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M. Tech. II Semester (MACHINE DESIGN)

(7PF528) MACHINE DYNAMICS LABORATORY

Experiments:

1. Determination of damped natural frequency of vibration of the vibrating system with different viscous oils
2. Determination of steady state amplitude of a forced vibratory system
3. CAM Analysis-Study of Jump Phenomena.
4. Determination of the magnitude and orientation of the balancing mass in Static balancing and dynamic balancing
5. Turn Table apparatus for determination of Moment of Inertia.
6. Determination of the magnitude of gyroscopic couple, angular velocity of precession, and representation of vectors.
7. Determination of characteristic curves of watt governor.
8. Determination of critical speed of Whirling of shaft.
9. To measure the power transmission for various input power condition with varied belt tension.
10. Determination of characteristic curves of proell governer and hartnell governor.
11. Determination of the coriolli's component of acceleration.
12. Determination of torque on epicyclic gear train by holding the sun and planet gears.