ACHARYA NAGARJUNA UNIVERSITY

NAGARJUNA NAGAR, GUNTUR – 522 510

ANDHRAPRADESH, INDIA

Regulations,
Scheme of Instruction,
Examination and Syllabi

for

MACHINE DESIGN

2-Year M.Tech. Degree Course
in Mechanical Engineering
(Semester System)

w.e.f.: 2011-2012

ACHARYA NAGARJUNA UNIVERSITY:: NAGARJUNA NAGAR
REVISED REGULATIONS FOR
TWO - YEAR M.TECH. DEGREE COURSE
(CREDIT BASED SYSTEM)

(With effect from the batch of students admitted during the academic year 2011-2012).

1. ELIGIBILITY FOR ADMISSION

1.1 The candidates, both non-sponsored and sponsored, for Admission into M.Tech programme shall have one of the following qualifications.

S.No.	Programme	Qualifications
1	Chemical Engineering	Bachelor Degree in Chemical Engineering / Chemical Technology / Biotechnology or its equivalent Degree recognized by Acharya Nagarjuna University.
2	Civil Engineering	Bachelor Degree in Civil Engineering or its equivalent Degree recognized by Acharya Nagarjuna University.
3	Computer Science and Engineering	B.Tech/B.E Computer Science and Engineering/Information Technology/M.C.A/M.Sc. Computers/M.Sc. Eletronics/M.Sc. Mathematics or its equivalent Degree recognized by Acharya Nagarjuna University.
4	Electrical and Electronics Engineering	Bachelor Degree in Electrical & Electronics Engineering/Electrical Engineering/ Electrical Power Engineering/ AMIE (Electrical Engineering) or its equivalent Degree recognized by Acharya Nagarjuna University.
5	Electronics and Communication Engineering	Bachelor Degree in Electronics & Communication/ Electronic & Instrumentation Engineering/AMIE or its equivalent Degree recognized by Acharya Nagarjuna University.
6	Mechanical Engineering	Bachelor Degree in Mechanical Engineering or its equivalent Degree recognized by Acharya Nagarjuna University.

1.2 Admission of Non-sponsored category students : Admission of non-sponsored category students is made on the basis of GATE/PGECET rank. When GATE/PGECET qualified candidates are not available, admission will be on the basis of merit in the qualifying examination. Students with or without GATE/PGECET rank should have obtained a minimum of 50% marks in the qualifying examination to become eligible for admission.

Reservation of seats to the candidates belonging to Scheduled Castes and Scheduled Tribes is as prescribed by the State Govt./University from time to time. If suitable candidates are not available to fill all the seats reserved for S.T category, they shall be filled by students S.C. Category and vice-versa.

If suitable candidates are not available for reserved seats, they shall be filled by the general category candidates.

1.3 Admission of Sponsored Category students: Sponsored category students should have at least 50% marks in the qualifying examination to become eligible for admission to

the Post Graduate Programme. Preference will be given to those candidates who are GATE/PGECET qualified.

The candidates must have a minimum of two years of full time work experience in a registered firm / company/ industry / educational and research institutions / any government department or government autonomous organizations in the relevant field in which the admission is being sought.

A letter from the employer must be furnished stating that the candidate is being sponsored to get admission. The employer should also indicate that the candidate will not be withdrawn midway till the completion of course. The rule of reservation shall not apply to the admission of sponsored category students.

1.4 The total number of full time candidates admitted into a course with or without GATE/PGECET rank should not exceed the sanctioned strength.

2.0 MEADIUM OF INSTRUCTION, DURATION AND STRUCTURE

2.1. The medium of instruction shall be in English.

2.2. The minimum and maximum period for completion of the P.G. Programme is 4 Semesters and 8 Semesters respectively for full time students.

2.3. Each Semester shall normally spread over sixteen weeks.

(a) The Programme may consist of

i. Core Courses
ii. Elective Courses
iii. Seminars
iv. Project Work

(b) The structure of the Programme comprises of two semesters of course work consisting of 6 Core subjects + 6 Elective subjects plus (3 Labs + 1 Seminar) or (2 Labs + 2 Seminar) followed by two semesters of Project work. In the third semester the student should give a project seminar. At the end of fourth semester the students should submit Project Thesis.

2.4. Project work shall be carried out under the Supervision of a Faculty Member in the concerned department.

2.5. A candidate may, however, in certain cases, be permitted to work on his Project/Dissertation at the place of employment, any recognized Institution/R&D Organization/Industry with the approval of the Head of the Department concerned and Head of the Organization. In such cases, the Project Work shall be jointly supervised by a member of the faculty and a person from the Organization holding a minimum of P.G. Degree in the concerned area of specialization.

2.6. Five copies of the Project Report certified by the Supervisor(s) and the Head of the Department concerned shall be submitted within one Calendar Year after completion of the second semester.

2.7. The student is eligible for the submission of M.Tech. Project Report at the end of fourth semester if he/she passed all the course work in the first & second semesters.

2.8. In a special case, if any candidate unable submit his/her Project Report at the end of fourth semester due to ill health or any other reason permitted by the head of the institution, he/she will be allowed submit at a latter date and the viva-voce examination will be conducted separately.

3.0. **ATTENDANCE**

3.1 The candidate shall put up a minimum of 75% attendance in each subject.

3.2. Condonation of shortage in attendance up to 10% in any subject may be condoned by the University on the recommendations of the Principal of the concerned College for reasons of ill health and the application is submitted at the time of actual illness and is supported by a certificate from the authorized Medical Officer approved by the Principal.

3.3. If the candidate does not satisfy the attendance requirement in any subject he or she shall not be permitted to appear for the University examination in that subject and has to repeat that subject when next offered or study any other specified subject as may be required. In case of repetition the new internal marks be taken into aMDount.

3.4. Failure in securing minimum prescribed attendance in any subject of previous Semester (s) is no bar for enrollment to the next semester.

4.0. **EVALUATION**

4.1 The performance of the candidate in each semester shall be evaluated subject wise. The maximum marks for each subject, seminar etc, will be as prescribed in the curriculum. The Internal Evaluation for Theory subjects shall be based on the best of the performances in the two midterm examinations one held in the middle of the semester and another held immediately after the completion of the instruction. The internal evaluation for practical subjects is based on the day to day performance and semester end internal practical Examination.

4.2 The marks for Seminar will be awarded by internal evaluation made by two staff members of the faculty of the department concerned.

4.3 For taking the University examination in any theory or practical subject, candidates shall be required to obtain a minimum of 50% marks in Internal evaluation in that subject failing which he/she shall be required to repeat the course in that subject when next offered or study any other specified subject as may be required. In case of repetition the new internal marks will be taken into aMDount.

4.4 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he or she secures a minimum of 50% marks in internal evaluation.

4.5 In case the candidate does not secure the minimum academic requirement in any subject he/she has to reappear in the University examination in that subject or any equivalent subject prescribed

4.6 Failure to attain the minimum academic requirement in any subject of previous semester (s) is no bar for enrollment to the next semester.

4.7 The performance of the students in each semester shall be evaluated subject wise The distribution of marks between sessional work (based on internal assessment) and University Examination will be as follows:

Nature of the subject	Sessional Marks	University Exam. Marks
Theory subjects	30	70
Practicals	30	70
Seminar	100	--
Project work	50	150 (Viva voce)

5. AWARD OF CREDITS

Credits are awarded for each Theory/Practical/Seminar/Project Subjects. Each theory subject is awarded 4 credits and each practical/Seminar subjects is awarded 2 credits. Project seminar in III Semester is awarded 8 credits and Project Viva-voce at the end of IV Semester is awarded 16 credits.

6. AWARD OF GRADES

S.No.	Range of Marks	Grade	Grade Points
1	≥85%	S	10.0
2	75%-84%	A	9.0
3	65%-74%	B	8.0
4	60%-64%	C	7.0
5	55%-59%	D	6.0
6	50%-54%	E	5.0
7	≤49%	F(Fail)	0.0
8	The grade 'W' represents withdrawal/absent (subsequently changed into pass or E toS or F grade in the same semester)	W	0.0

A Student securing 'F' grade in any subject there by securing 0 grade points has to reappear and secure at least 'E' grade at the subsequent examinations in that subject

'W' denotes withdrawal/absent for a subject

- After results are declared and Grade sheets will be issued to each student which will contain the following details:
- The list of subjects in the semester and corresponding credits and Grade obtained
- The Grade point average(GPA) for the semester and
- The Cumulative Grade Point Average(CGPA) of all subjects put together up to that semester from first semester onwards

GPA is calculated based on the fallowing formula:

$$\frac{\text{Sum of [No.Credits X Grade Point]}}{\text{Sum of Credits}}$$

CGPA will be calculated in a similar manner, considering all the subjects enrolled from first semester onwards.

7. AWARD OF DEGREE AND CLASS

A candidate who becomes eligible for the award of the degree shall be placed in the following three divisions based on the CGPA secured by him/her for the entire Programme

S.No.	Class	CGPA
1	First Class With Distinction	8.0 or more
2	First Class	6.5 or more but less than 8.0
3	Second Class	5.0 or more but less than 6.5

8. WITH-HOLDING OF RESULTS

The result of a candidate may be withheld in the following cases

i. The candidate has not paid dues to the institution

ii. A case of indiscipline is pending against the candidate

iii. A case of malpractice in examination is pending against the candidate The issue of degree is liable to be withheld in such cases

9. GENERAL

8.1 The University reserves the right of altering the regulations as and when necessary.

8.2 The regulations altered will be applicable to all the candidates on the rolls irrespective of the fact that the regulations at the time of admission of the student to the programme are different

8.3 The Academic Regulations should be read as a whole for purpose of any Interpretation Whenever there is a dispute regarding interpretation of regulations, the decision of the Vice-Chancellor is final.

ACHARYA NAGARJUNA UNIVERSITY : NAGARJUNA NAGAR

SCHEME OF EXAMINATION AND INSTRUCTION FOR I/II M.TECH.

I/II M.TECH (MACHINE DESIGN) :: FIRST SEMESTER

Sl. No	Code No & Subject	Hours / Week		Credits	Evaluation of Marks			
		Lecture	Practical		Internal	External		Total
						Theory	Practical	
1.	MT/ME/MD-511 Computer Aided Design	4	--	4	30	70	--	100
2	MT/ME/MD – 512 FEM	4	--	4	30	70	--	100
3	MT/ME/MD – 513 Theory of Elasticity and Plasticity	4	--	4	30	70	--	100
4	MT/ME/MD- 514 **Elective- I**	4	--	4	30	70	--	100
5	MT/ME/MD – 515 **Elective – II**	4	--	4	30	70	--	100
6	MT/ME/MD-516 **Elective-III**	4	--	4	30	70	--	100
7	MT/ME/MD – 551 Modelling Lab	--	6	2	30	--	70	100
8	MT/ME/MD – 552 Analysis Lab	--	6	2	30	--	70	100
	TOTAL	24		28				800

Elective-I

MT/ME/MD – 514/A	Design of Mechanisms & Manipulators
MT/ME/MD – 514/B	Design for Manufacturing
MT/ME/MD – 514/C	Design of Pressure Vessels

Elective-II

MT/ME/MD – 515/A	Mechanical Vibrations
MT/ME/MD – 515/B	Nanotechnology
MT/ME/MD – 515/C	Advances in Manufacturing Technology

Elective – III

MT/ME/MD-516/A	Design of Experiments
MT/ME/MD-516/B	Computational Fluid Dynamics
MT/ME/MD-516/C	Computational Methods

ACHARYA NAGARJUNA UNIVERSITY : NAGARJUNA NAGAR

SCHEME OF EXAMINATION AND INSTRUCTION FOR I/II M.TECH.

I/II M.TECH (MACHINE DESIGN) :: SECOND SEMESTER

Sl. No	Code No & Subject	Hours / Week		Credits	Evaluation of Marks			
		Lecture	Practical		Internal	External		Total
						Theory	Practical	
1.	MT/ME/MD-521 Advanced Mechanisms Design	4	--	4	30	70	--	100
2	MT/ME/MD – 522 Robotics	4	--	4	30	70	--	100
3	MT/ME/MD – 523 Optimization Techniques	4	--	4	30	70	--	100
4	MT/ME/MD- 524 **Elective- IV**	4	--	4	30	70	--	100
5	MT/ME/MD – 525 **Elective – V**	4	--	4	30	70	--	100
6	MT/ME/MD-526 **Elective-VI**	4	--	4	30	70	--	100
7	MT/ME/MD – 561 Machine Dynamics Lab	--	6	2	30	--	70	100
8	MT/ME/MD – 562 MiniProject/Seminar	--	6	2	30	--	70	100
TOTAL		24		28				800

Elective-IV

MT/ME/MD- 524/A	Tool Design
MT/ME/MD- 524/B	Reliability Engineering
MT/ME/MD- 524/C	Quality Engineering

Elective-V

MT/ME/MD-525/A	Gear Engineering
MT/ME/MD-525/B	Experimental Stress analysis
MT/ME/MD-525/C	Mechanics of Composite Materials

Elective – VI

MT/ME/MD-526/A	Mechatronics
MT/ME/MD-526/B	Mechanics of Fracture & Fatigue
MT/ME/MD-526/C	Tribology

ACHARYA NAGARJUNA UNIVERSITY : NAGARJUNA NAGAR

SCHEME OF EXAMINATION AND INSTRUCTION FOR II/II M.TECH.

II/II M.TECH (MACHINE DESIGN) :: FIRST SEMESTER

Sl. No	Code No & Subject	Hours / Week			Credits	Evaluation of Marks		
		Lecture	Tutorial	Practical		Internal	External	Total
1.	MT/ME/MD-651 Project Seminar	-	---	24	8	100	--	100

ACHARYA NAGARJUNA UNIVERSITY : NAGARJUNA NAGAR

SCHEME OF EXAMINATION AND INSTRUCTION FOR II/II M.TECH.

II/II M.TECH (MACHINE DESIGN) :: SECOND SEMESTER

Sl. No	Code No & Subject	Hours / Week			Credits	Evaluation of Marks		
		Lecture	Tutorial	Practical		Internal	External	Total
1.	MT/ME/MD-661 Project Viva	--	--	24	16	50	150	200

MT/ME/MD 511 :: COMPUTER AIDED DESIGN

I Year M.Tech. (Machine Design) :: First Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT – I

Typical Product Cycle, Implementation of a typical CAD process, Application of CAD and their Advantages

3D modeling and viewing: Introduction, Modeling Approaches, Types of Geometric Models, Coordinate System, sketching and Sketch Planes, Parameters and Dimensions, Basic Features, Datum Features, Geometric Constraints, Modeling Operations and Strategies

Modeling Aids and Tools: Introduction, Geometric Modifiers, Layers, Colors, Grids, Groups, Dragging and Rubbering, Clipping, Entity Selection methods, Geometric Arrays, Transformat**ions**, Editing.

UNIT – II

Geometric Modeling: Types of Curves and Curve Manipulations, Types of Surfaces and Surface Manipulations, *Solids:* Introduction, Geometry and Topology, Solid Entities, Fundamentals of Solid Modeling, Boundary Representation (B-rep), Constructive Solid Geometry (CSG) – examples, Sweeps and Solid Manipulations

Feature based Modeling: Introduction, Feature Entities, Parametrics, Feature Manipulations

Rapid Proto Typing: Introduction, RP activities, RP applications, RP techniques: Stereo-lithography, Selective Laser Sintering, 3 – D Printing, Fused Deposition Modeling and Laminated Object Manufacturing.

UNIT – III

Visualization: Introduction, Model clean up, Hidden-Line Removal, Hidden Surface Removal, Hidden Solid Removal, Shading, Colors

Computer Animation: Introduction, Animation Types, Key Frame Technique

Product Data Exchange: Introduction, Types of Translators, IGES, Processors

UNIT – IV

Assembly Modeling: Introduction, Assembly Modeling, Assembly Tree, Assembly Planning, Mating Conditions, Bottom – Up and Top – Down Assembly Approaches with examples

Tolerance Analysis and Mass Property calculations

Collaborative Design: Traditional design, Collaborative Design, Principles and Approaches

Product Lifecycle Management: Introduction, Product Information, PLM Frame Work, Benefits

TEXT BOOK:

1. "Mastering CAD/CAM" by Ibrahim Zeid, Tata McGraw-Hill Edition, New Delhi

REFERENCES:

a. CAD/CAM by PN Rao, PHI
b. CAD/CAM – Theory and Practice by Ibrahim Zeid, MGH International
c. CAD/CAM – Computer Aided Design and Manufacturing by Mikell P Groover and Emory W Zimmers Jr., Prentice Hill, International

MT/ME/CC 512 :: FINITE ELEMENT ANALYSIS

I Year M.Tech. (Machine Design) :: First Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

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.
One-dimensional finite element methods: Bar elements, temperature effects. Element matrices, assembling of global stiffness matrix, Application of boundary conditions, Elimination and penalty approaches, solution for displacements, reaction, stresses, temperature effects, Quadratic Element, Heat transfer problems: One-dimensional, conduction and convection problems. Examples: - one dimensional fin,

UNIT – II

Trusses: Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses, temperature effects.
Beams and Frames: Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses.

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.
Isoparametric formulation: Concepts, sub parametric, super parametric elements, numerical integration. Higher order Elements

UNIT – IV

Finite elements in Structural Dynamics: Dynamic equations, eigen value problems, and their solution methods, simple problems.
Convergence: Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, pascal's triangle.

TEXT BOOK:

1. Finite element methods by Chandrubptla & 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. J. N. Oden, Finite Element of Nonlinear continua, McGraw-Hill, New York, 1971
4. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996

MT/ME/MD 513 :: THEORY OF ELASTICITY & PLASTICITY

I Year M.Tech. (Machine Design) :: First Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT I

Elasticity: Two dimensional stress analysis - Plane stress - Plane strain - Equations of compatibility - Stress function - Boundary conditions.

Problem in rectangular coordinates - Solution by polynomials - Saint Venent's principles - Determination of displacement - Simple beam problems.

UNIT II

Problems in polar coordinates - General equations in polar coordinates - Stress distribution symmetrical about axis - Strain components in polar coordinates - Simple and symmetric problems.

Analysis of stress and strain in three dimensions - Principle stresses – Homogeneous deformations - Strain spherical and deviatoric stress - Hydrostatic strain.

UNIT III

General theorems: Differential equations of equilibrium and compatibility - Displacement - Uniqueness of solution - Reciprocal theorem.

Bending of prismatic bars - Stress function - Bending of cantilever beam - Beam of rectangular cross-section - Beams of circular cross-section.

UNIT IV

Plasticity: Plastic deformation of metals - Structure of metals - Deformation - Creep stress relaxation of deformation - Strain rate condition of constant maximum shear stress - Condition of constant strain energy - Approximate equation of plasticity.

Methods of solving practical problems - The characteristic method - Engineering method - Compression of metal under press - Theoretical and experimental data drawing.

REFERENCES:

1. Theory of Elasticity by Timoshenko, S.P. and Goodier, J.N.
2. An Engineering Theory of Plasticity by E.P. Unksov.
3. Applied Elasticity by W.T. Wang.
4. Theory of Plasticity by Hoffman and Sacks.

ELECTIVE-I

MT/ME/MD-514/A :: DESIGN OF MECHANISMS & MANIPULATORS

I Year M.Tech. (Machine Design) :: First Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT - I

Mobility analysis – Degree of freedom (DOF), mixed mobility, total, partial and fractional DOF. Closed and open chain systems, structural analysis and synthesis of mechanisms.

UNIT - II

Alternative design solutions, coding, evaluation and selection of optimum mechanism, type synthesis, number synthesis and design of mechanisms.

UNIT - III

Indexes of merit, graphical, algebraic and optimization techniques, matrix methods of design and analysis, design of function, path and motion generators, structural and mechanical error

UNIT - IV

Manipulators – Classification, actuation and transmission systems, coordinate transformation – DH notations, inverse and forward kinematics, manipulator dynamics from Lagrangian and Newtonian point of view.

REFERENCES:

1. George N Sandor and Arthur G Erdman, Mechanism Design, VOL – 1, PHI, 1988
2. George N Sandor and Arthur G Erdman, Mechanism Design, VOL – 2, PHI, 1988
3. Mechanisms & Mechines (Analysis & Syntheis)by Arthur Erdman
4. Klafter R.D., Cmielewski T.A. and Negin M ., "Robot Engineering An Intergrated approach", Prentice Hall of India,New Delhi,1994
5. Deb S.R. , "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Co., Ltd.,1994

ELECTIVE-I

MT/ME/MD-514/B :: DESIGN FOR MANUFACTURING

I Year M.Tech. (Machine Design) :: First Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT- I

Introduction: General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances - Geometric tolerances - Assembly limits – Datum features - Tolerance stacks

UNIT- II

Factors Influencing Form Design: Working principle, Material, Manufacture, Design - Possible solutions - Materials choice - Influence of materials on from design - from design of welded members, forgings and castings.

UNIT –III

Component Design-Machining Consideration: Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area - simplification by separation - simplification by amalgamation - Design for machinability .

Component Design - Casting Considerations: Redesign of castings based on parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores.

UNIT -IV

Design for Manufacture and Case Studies: Identification of uneconomical design, Design for economy , Design for clampability - Design for accessibility - Modifying the design , Design for assembly , Group technology - Computer Applications for DFMA

TEXT BOOK:

Harry Peck, "Design for Manufacture", Pittman Publication, 1983.

REFERENCES:

1. Robert Matousek, "Engineering Design - A systematic approach", Blackie & sons Ltd.
2. James G. Bralla, "Hand Book of Product Design for Manufacturing", McGraw Hill Co.
3. Swift K.G., "Knowledge based design for manufacture, Kogan Page Ltd., 1987.

ELECTIVE-I

MT/ME/MD-514/C :: PRESSURE VESSEL DESIGN

I Year M.Tech. (Machine Design) :: First Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

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.

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

UNIT – II

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.

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 – III

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.

UNIT – IV

Stress concentrations: Influence of surface effects on fatigue, effect of the environment and other factors on fatigue life, thermal stress fatigue, creep and rupture of metals at elevated temperatures, hydrogen embrittlement of pressure vessel steels, brittle fracture, effect of environment on fracture toughness, fracture toughness relationships, criteria for design with defects, significance of fracture mechanics evaluations, effect of warm prestressing on the ambient temperature toughness of pressure vessel steels.

Design features: Localized stresses and their significance, stress concentration at a variable thickness transition section in a cylindrical vessel, stress concentration about a circular hole in a plate subjected to tension, elliptical openings, stress concentration, stress concentration factors for superposition, dynamic and thermal transient conditions, theory of reinforced openings, nozzle reinforcement, placement and shape, fatigue and stress concentration.

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.

ELECTIVE-II

MT/ME/MD 515/A :: MECHANICAL VIBRATIONS

I Year M.Tech. (Machine Design) :: First Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT I

Fundamentals of vibration Review of Single degree system - Response to arbitrary periodic excitations - Duhamel's Integral – Impulse Response function - Virtual work - Lagrange's equation - Single degree freedom forced vibration with elastically coupled viscous dampers - System Identification from frequency response - Transient Vibration - Laplace transformation formulation.

Two degree of freedom systems Free vibration of spring - coupled system - mass coupled system - Bending vibration of two degree of freedom system - forced vibration - Vibration Absorber - Vibration isolation

UNIT II

Multi-degree of freedom system Normal mode of vibration - Flexibility Matrix and Stiffness matrix - Eigen values and eigen vectors - orthogonal properties - Modal matrix- Modal Analysis - Forced Vibration by matrix inversion – Modal damping in forced vibration - Numerical methods for fundamental frequencies.

UNIT III

Vibration of continuous systems Systems governed by wave equations - Vibration of strings - vibration of rods - Euler Equation for Beams - Effect of Rotary inertia and shear deformation - Vibration of plates

UNIT IV

Experimental methods in vibration analysis Vibration instruments - Vibration exciters Measuring Devices - Analysis - Vibration Tests - Free and Forced Vibration tests. Examples of Vibration tests - Industrial case studies

REFERENCES:

1. Thomson, W.T. - "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990
2. Rao, J.S., & Gupta, K. - "Introductory Course on Theory and Practice of Mechanical Vibrations", New Age International Ltd., 1984
3. Den Hartog, J.P. "Mechanical Vibrations", Dover Publication, 1990
4. Rao, S.S., "Mechanical Vibrations", Addison Wesley Longman, 1995

ELECTIVE-II

MT/ME/MD 515/B :: NANOTECHNOLOGY

I Year M.Tech. (Machine Design) :: First Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT – I

Introduction: Size and shape dependence of material properties at the nanoscale, why is small good? limits to smallness, scaling relations, can nanorobots walk and nanoplanes fly? Nanoscale elements in conventional technologies

Top-down and bottom-up nanofabrication: The Intel-IBM approach to nanotechnology: lithography, etching, ion implantation, thin film deposition, Electron beam lithography, Soft lithography: nano imprinting and micro contact printing, Solution/plasma-phase nanofabrication, sol-gel methods, template techniques.

Unit-III

Self assembly and self-organization

Functional coatings with self assembled monolayers of molecules and nanoparticles Langmuir-Blodgett films, layer-by-layer growth.

Imaging/characterization of nanostructures

General considerations for imaging, Scanning probe techniques: SEM, STM, AFM, NSOM.

UNIT – III

Metal and semiconductor nanoparticles: Synthesis, stability, control of size, Optical and electronic properties, Ultra-sensitive imaging and detection with nanoparticles, bioengineering applications, Catalysis.

Semiconductor and metal nanowires: Vapor/liquid/solid growth and other synthesis techniques, Nanowire transistors and sensors.

UNIT – IV

Carbon Nanotubes : Structure and synthesis, Electronic, vibrational, and mechanical properties, How can C Nanotubes enable faster computers, brighter TV screens, and stronger mechanical reinforcement

Mechanics at nanoscale: Enhancement of mechanical properties with decreasing size, Nanoelectromechanical systems, Nanomachines, Nanofluidics, Filtration, Sorting, Molecular motors

Text Books:

1. Nanoscale Science and Technology by Kelsall, Hamley, and Geoghegan, Wiley (2005)
2. Introduction to Nanoscale Science and Technology by Di Ventra, Evoy, and Heflin, Kluwer Academic Publishers (2004).

References:

1. Introduction to Nanotechnology by Poole and Owens, Wiley (2003).
2. Nanochemistry: A Chemical Approach to Nanomaterials, Ozin and Arsenault, RSC Publishing

ELECTIVE-II

MT/ME/MD 515/C :: ADVANCES IN MANUFACTURING TECHNOLOGY

I Year M.Tech. (Machine Design) :: First Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT – I

Welding Processes: Fusion and Solid state welding process, Automation in Welding, Design aspects of welds, Weldability of aluminium alloys, titanium alloys and High strength low alloy steels, Non destructive testing of welds, Residual stresses and distortion in weldments.
Surface Processing Operations: Plating and Related Processes, Conversion Coatings, Physical Vapor Deposition, Chemical Vapor Deposition, Organic Coatings, Porcelain Enameling and other Ceramic coatings, Thermal and Mechanical Coating Processes.

UNIT – II

Un-conventional Machining Methods-I: Abrasive jet machining - Elements of the process, mechanics of metal removal process parameters, economic considerations, applications and limitations, recent developments.
Ultrasonic machining: Elements of the process, machining parameters, effect of parameters on surface finish and metal removal rate, mechanics of metal removal process parameters, economic considerations, applications and limitations. Wire EDM Process: General Principle and applications of Wire EDM, Mechanics of metal removal, Process parameters, selection of tool electrode and dielectric fluids, methods surface finish and machining accuracy.

UNIT – III

Un-conventional Machining Methods-II: Electro-Chemical Processes: Fundamentals of electro chemical machining, metal removal rate in ECM, Tool design, Surface finish and accuracy economics aspects of ECM. Electron Beam Machining: Generation and control of electron beam for machining, theory of electron beam machining, principle, advantages, limitations, comparison of thermal and non-thermal processes. Plasma Arc Machining: Principle, machining parameters, effect of machining parameters on surface finish and metal removal rate, applications, limitations. Laser Beam Machining: Principle, effect of machining parameters on surface finish, applications, and limitations.

UNIT – IV

Rapid Prototyping: Working principle, methods - Steriolithography, Laser sintering, Fused deposition method, applications and limitations.
Nano Technology: Nano milling processes, wet milling, dry milling, nano materials, fabrication of nano tubes, advantages of nano tubes, mechanical properties.

TEXT BOOKS:

1. Manufacturing Technology - P. N. Rao, TMH Publishers
2. Fundamentals of Modern Manufacturing, Mikell P. Groover, John Wiley & Sons Publishers

REFERENCES:

1.Production Technology – HMT 2.Manufacturing Science – Cambel 3.Welding Technology - R.S, Parmar, 4.Introduction to Nanotechnology - Poole and Owens, Wiley

ELECTIVE-III

MT/ME/MD 516/A :: DESIGN OF EXPERIMENTS

I Year M.Tech. (Machine Design) :: First Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT-I

Introduction : Strategy of experimentation, some typical applications of experimental design, Basic principles, Guidelines for designing experiments, A brief history of statistical design, Using statistical design in experimentation.

Simple comparative experiments : Introduction, Basic statistical concepts, Sampling and sampling Distribution, Inferences about the Differences in means, randomized designs, Inferences about the Differences in means, Paired comparison Designs, Inferences about the Variances of Normal Distributions.

UNIT-II

Randomized Block Designs : Randomized complete block design, Latin square design, Balanced incomplete block design.

Introduction To Factorial Design : Basic definition and principles, Advantages of factorials, The two factor factorial design, General factorial design, Fitting response curves and surfaces, Blocking in a factorial design.

UNIT-III

Fitting Regression Models : Introduction, Linear regression models, Estimate of parameters in linear regression models, Hypothesis testing in multiple regression, Confidence intervals in multiple regression, Prediction of new response observations, Regression model diagnostics, testing for lack of fit

Analysis Of Variance (Anova) : Introduction, Example of ANOVA process, Degrees of freedom, Error variance and pooling, Error variance and application, Error variance and utilizing empty columns, the F-test.

UNIT-IV

Taguchi Method Of Design Of Experiments : Concept design, Parameter design, Tolerance design, Quality loss function, Signal-to- Noise ratio, Orthogonal array experiments, Analysis of Mean(ANOM), Quality characteristics, Selection and testing of noise factors, Selection of control factors, Parameter optimization experiment, Parameter design case study.

REFERENCES:

1. Douglas C Montgomery, “Design and Analysis of Experiments”, John Wiley.
2. John P.W.M., “Statistical Design and Analysis of Experiments”, Macmillan.
3. Montgomery D.C., Runger G. C., “Introduction to Linear Regression Analysis”, John Wiley
4. Myres R.H., Montgomery D. C., “Response Surface Methodology: Process And Product Optimisation Using Designed Experiments”, Wiley, New York
5. Taguchi, “Introduction to Quality Engineering”, Asian Productivity Organisation, G. UNIPUB, White Plains, New York.

ELECTIVE-III

MT/ME/MD 516/B :: COMPUTATIONAL FLUID DYNAMICS

I Year M.Tech. (Machine Design) :: First Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

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

UNIT III

Treatment of compressible flows: potential equation, Eluer equations, Navier-stokes system of equations, flowfield-dependent variation methods, boundary conditions, example problems.
Finite volume method: Finite volume method via finite difference method, formulations for two and three-dimensional problems.

UNIT – IV

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.

ELECTIVE-III

MT/ME/MD 516/C :: COMPUTATIONAL METHODS

I Year M.Tech. (Machine Design) :: First Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT – I

Introduction to numerical methods applied to engineering problems: Examples, solving sets of equations, Matrix notation, Determinants and inversion, Iterative methods, Relaxation methods , System of non-linear equations , computer programs
Numerical integration: Newton-Cotes integration formulas, Simpson's rules, Gaussian quadrature. Adaptive integration

UNIT – II

Optimization: One dimensional unconstrained optimization, multidimensional unconstrained optimization –direct methods and gradient search methods, constrained optimization
Boundary value problems and characteristic value problems: Shooting method – Solution through a set of equations – Derivative boundary conditions – Rayleigh – Ritz method – Characteristic value problems.

UNIT – III

Numerical solutions of partial differential equations: Laplace's equations – Representations as a difference equation – Iterative methods for Laplace's equations – poisson equation – Examples, Derivative boundary conditions , Irregular and non , rectangular grids , Matrix patterns, sparseness , ADI method , Finite element method.
Parabolic partial differential equations: Explicit method – Crank-Nickelson method – Derivative boundary condition – Stability and convergence criteria – Finite element for heat flow – computer programs.

UNIT – IV

Hyperbolic partial differential equations: Solving wave equation by finite differences-stability of numerical method , method of characteristics-wave equation in two space dimensions-computer programs.
Curve fitting and approximation of functions: Least square approximation fitting of non-linear curves by least squares, regression analysis, multiple linear regression, non linear regression - computer programs.

TEXT BOOKS:

1. Steven C.Chapra, Raymond P.Canale "Numerical Methods for Engineers" Tata Mc-Graw hill
2.Curtis F.Gerald, partick.O.Wheatly, "Applied numerical analysis" Addison-wesley,1989
3.Douglas J..Faires,Riched Burden "Numerical methods" Brooks/cole publishing company,1998.

REFERENCES:

1.Ward cheney &David Kincaid "Numerical mathematics and computing" Brooks/cole publishing company1999,fourth edition.
2.Riley K.F.M.P.Hobson&Bence S.J, "mathematical methods for physics and engineering" Cambridge university press,1999.

MT/ME/MD-551 :: MODELLING LAB

I Year M.Tech. (Machine Design) :: First Semester

Practicals	*: 6 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

Exercises will be given on Modeling of mechanical Components using packages like PRO/ENGINEER, Uni-Graphics, CATIA, Autodesk INVENTOR, Solid works etc.

1. Creation of working drawings of components and preparation of assembly models of screw jack, leaf jig, plumber block, lathe chuck, machine-vice, box type drilling jig assembly etc. by using the following techniques:

-Generation of surfaces of revolution

-Generation of surfaces of extrusion

-Generation of surfaces by skinning operation

-Generation of solid models using constructive solid geometry, method shading and rendering.

2. Generation of Ferguson's cubic surface patches, Generation of Bezier UNISURF surface patches, Generation of Coon's patches.

MT/ME/MD 552 :: ANALYSIS LAB

I Year M.Tech. (Machine Design) :: First Semester

Practicals	*: 6 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

Exercises will be given on Analysis of mechanical Components using packages like ANSYS/HYPERMESH/NASTRAN, etc..

I. Structural Analysis using any FEA Package for different structures that can be discretised with 1-D,2-D & 3-D elements

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

II. Thermal Analysis using any FEA Package for different structures that can be discretised with 1-D,2-D & 3-D elements

1. Steady state thermal analysis
2. Transient thermal analysis

III. Transient analysis using any FEA Package for different structures that can be discretised with 1-D,2-D & 3-D elements

1. Linear
2. Non-Linear (Geometrical Non-linearity)

IV Contact Analysis

V Crushing Analysis

MT/ME/MD 521 :: ADVANCED MECHANISMS DESIGN

I Year M.Tech. (Machine Design) :: Second Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT – I

Introduction: Review of fundamentals of kinematics – mobility analysis – formation of one D.O.F. multi loop kinematic chains, network formula – Gross motion concepts.

Kinematic Analysis: Position Analysis – vector loop equations for four bar, slider crank, inverted slider crank, geared five bar, and six bar linkages. Analytical solutions for velocity and acceleration analysis – human tolerance for acceleration – four bar linkage jerk analysis. Plane complex mechanisms – auxiliary point method **5**

UNIT - II

Path Curvature Theory: Fixed and moving centroids, inflection points and inflection circle, Euler savary equation, graphical constructions – cubic stationary curvature.

Synthesis of Mechanisms: Type synthesis – case study of casement window mechanisms Number synthesis – Associated linkage concept Dimensional synthesis – function generation, path generation, motion generation - Graphical methods – two, three positions, circle point and centre point circles – order synthesis of four bar function generation – four positions, special cases of four position synthesis – Finite Ball's point – five positions – cognate linkages

UNIT - III

Geared five bar and parallelogram six bar cognates, six bar parallel motion generator – coupler curve synthesis, design of six bar mechanisms for different applications including dwell. Algebraic methods – using vector loop equations and complex algebra, synthesis of multi loop linkage mechanisms, geared linkages, application of instant centre in linkage design. Practical considerations in mechanism design, mechanism defects.

UNIT - IV

Dynamics of Mechanisms: Static force analysis with friction – inertia force analysis – slider crank mechanism, four bar mechanism, crank – shaper mechanism – combined static and inertia force analysis, shaking force, kinetostatic analysis of a card bunch – time response of a four bar linkage, modification of the time response of a mechanism – virtual work. Introduction to force and moment balancing of linkages

Spatial Mechanisms and Robotics: Kinematic analysis of spatial RSSR mechanism – Denavit - Hartenberg parameters - Forward and inverse kinematics of robotic manipulators

REFERENCE BOOKS:

1. Sandor G.N, and Erdman A.G. Advanced Mechanism Design : Analysis and Syntheis, PHI, 1984.
2. Amitabha Ghosh and Ashok Kumar Mallik, Theory of Mechanism and Machines, EWLP, Delhi, 1994
3. Shigley, J.e., and Vicker, J.J. Theory of Mechanisms, McGrawHill, 1995.
4. Norton R.L. Design of machinery, McGrawHill, 1992.

MT/ME/MD 522 :: ROBOTICS

I Year M.Tech. (Machine Design) :: Second Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT-I

Fundamentals of Robots: Introduction to Robotics, major component so a robot, robotic like devices, classification of robots – Classification by coordinate system and by control method, Basic components of robot system, functions and specifications of robot, fixed versus flexible automation, overview of robot application.
Robot end Effectors: Introduction, end effectors, interfacing, types of end effectors, grippers and tools, considerations in the selection and design of remote centered devices.

UNIT-II

Actuators: Types, Characteristics of actuating system: weight, Power-to-weight ratio, Operating pressure, Stiffness vs. compliance, Use of reduction gears, Comparison of hydraulic, Electric, pneumatic, actuators, Hydraulic actuators, Proportional feedback control, Electric Motors: DC motors, Reversible AC motors, Brushless DC motors, Stepper motors- structure and principle of operation, Stepper motor speed-torque characteristics.
Sensors: Sensor characteristics, Position sensors- potentiometers, Encoders, LVDT, Resolvers, Velocity sensor- encoders, tachometers, Force and Pressure sensors - piezoelectric, force sensing resistor, Torque sensors, Touch and tactile sensor, Proximity sensors-magnetic, Optical, Ultrasonic, Inductive, Capacitive, Eddy-current proximity sensors.

UNIT-III

Robot Kinematics: Robots as mechanism, Matrix representation- representation of point, vector in space, representation of frame at origin and in reference frame. Homogeneous transformation Matrices, Representation of transformations – pure translation, pure rotation, combined transformations. Forward solution – Denavit Hartenberg procedure. Problems on simple 2R and 3R manipulator, Puma manipulator, SCARA manipulator, Inverse or backward solution – techniques, problems involved of 2R, 3R manipulator.

UNIT-IV

Velocity and Statics of Manipulators: Differential relationships, Jacobian, Differential motions of a frame (translation and rotation), Linear and angular velocities of links in serial 2R manipulators Jacobian of serial manipulator, Singularities.
Dynamics of Manipulators: Equation of motion of 2R manipulators using Lagrangian, Newton-Euler formulation. Introduction to trajectory planning, basics of trajectory planning.

TEXT BOOKS:

1. Robotic Engineering- an integrated approach - Richard D.Klafter, PHI
2. Introduction to Robotics Analysis - Niku, S. B., Systems, Applications, Pearson Education.

REFERENCE BOOKS:

1. Robotics and Control – R K Mittal and I J Nagrath
2. Introduction to Robotics: Mechanica and Control - 2nd Edition - Craig, J.J.
3. Fundamentals of Robotics, Analysis and Control - Schilling R. J., PHI, 2006.

MT/ME/MD 523 :: OPTIMIZATION TECHNIQUES

I Year M.Tech. (Machine Design) :: Second Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT I

General Characteristics of mechanical elements, adequate and optimum design, principles of optimization, formulation of objective function, design constraints -Classification of optimization problems and applications.
Single variable and multivariable optimization, Techniques of unconstrained minimization Golden Section, Fibona MDi and gradient search methods -Interpolation methods.

UNIT II

Optimization with equality and inequality constraints - Direct methods - Indirect methods using penalty functions, Lagrange multipliers; Geometric programming , Linear programming using simplex approach.

UNIT III

Introduction to Genetic Algorithms , Simulated Annealing , Neural networks and fuzzy logic techniques. Multi objective optimization.

UNIT IV

Design application - Structural applications - Design of simple truss members. Design of simple axial, transverse loaded members for minimum cost and /or weight, - Design of shafts and torsionally loaded members for minimum weight. Operations and planning applications, Analysis and Data Reduction applications, Classical Mechanics applications.

TEXT BOOKS:

1. A.Ravindran, K.M.Ragsdell & G.V.Reklaitis “Engineering Optimization Methods and Applications”, 2nd edition, Wiley publications
2. Singeresu S. Rao, "Engineering Optimization - Theory and Practice" New Age Intl. Ltd., Publishers, 2000.

REFERENCES:

1. Johnson Ray, C., "Optimum design of mechanical elements”, Wiley, John & Sons, 1981..
2. Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India, 1995.

ELECTIVE-IV

MT/ME/MD 524/A :: TOOL DESIGN

I Year M.Tech. (Machine Design) :: Second Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT I

Tool design methods Introduction, Design procedure, Statement of the problem, Needs Analysis – Tentative design solutions, Finished design, Drafting and design techniques in tooling drawings, Punch and die Manufacturing Techniques.

UNIT II

Tooling materials Introduction, Properties of tool materials, Metal cutting tools, Single-point cutting tools, Milling cutters, Drills and Drilling, Reamer classification, Taps, Tap classification, The selection of carbide cutting tools, Determining the insert thickness for carbide tools, Various heat treatments.

Gages and gage design Introduction, Fixed Gauges, Gauge Tolerances, The selection of material for Gages, Indicating Gages, and Automatic gages.

UNIT III

Design of Drill Jigs : Principles of location, Locating methods and devices, Principles of clamping, Drill jigs, Chip formation in drilling, General considerations in the design of drill jigs, Drill bushings, Methods of construction, Drill jigs and modern manufacturing, Computer aided Jig design.

Design of Fixtures : Introduction, Fixtures and economics, Types of Fixtures, Vise Fixtures, Milling Fixtures, Boring Fixtures, Broaching Fixtures, Lathe Fixtures, Grinding Fixtures, Types of Die construction, Computer aided Fixture Design,

Design of Dies : Die-design fundamentals, Blanking and Piercing die construction, Pilots, Strippers and pressure pads, Presswork materials, Strip layout, Short -run tooling for Piercing, Bending dies ,Forming dies, Drawing operations.

UNIT IV

Tool design for numerically controlled machines Introduction, The need for numerical control, A basic explanation of numeric control, Numerical control systems in use today, Fixture design for numerically controlled machine tools, Cutting tools for numerical control, Tool holding methods for numerical control, Automatic tool changers and tool positioners, Tool presetting, Introduction, General explanation of the Brown and Sharpe machine, tooling for Automatic screw machines.

Text Books

1. Donaldson, Cyrll, George H. LeCain, Goold, V.C., "Tool Design", Tata McGraw Hill Publishing Company Ltd., 36th Reprint 2006.
2. Joshi, Prakash Hiralal, "Tooling data", Wheeler Publishing, 2000
3. Sharma, P.C., "Machine Tool and Tool Design ", S Chand Company. 2004.
4. Mehta N.K., "Machine Tool Design", Tata McGraw Hill, 1989.
5. Paquin, J. R. and Crowley, R. E., Die design fundamentals, Ind. Press Inc., New York,1987

ELECTIVE-IV

MT/ME/MD 524/B :: RELIABILTY ENGINEERING

I Year M.Tech. (Machine Design) :: Second Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT I

Reliability concepts : Reliability function - failure rate - Mean time between failures (MTBF) - Mean time to failure (MTTF) - a priori and a posteriori concept - mortality curve - useful life availability - maintainability

UNIT II

Reliability data analysis : Time to failure distributions - Exponential, normal, Gamma, Weibull, ranking of data - probability plotting techniques - Hazard plotting.

UNIT III

Reliability prediction models

Series and parallel systems - RBD approach - Standby systems - m/n configuration - Application of Baye's theorem - cut and tie set method - Markov analysis - FTA - Limitations.

UNIT IV

Reliability testing and monitoring:

Life testing, requirements, methods, test planning, data reporting system, data reduction and analysis, reliability test standards, Reliability growth monitoring-Non parametric methods Reliability and life cycle costs -Reliability allocation - Replacement model.

Risk assessment

Definition and measurement of risk - risk analysis techniques - risk reduction resources - industrial safety and risk assessment.

TEXT BOOKS:

1. L.S. Srinath “Reliability Engineering”, Fourth Edition, East-West Press
2. E. Balagurusamy “Reliability Engineering”,Tata McGraw-Hill

REFERENCES:

1. Modarres, " Reliability and Risk analysis ", Mara Dekker Inc., 1993.
2. Smith C.O." Introduction to Reliability in Design ", McGraw Hill, London, 1976.

ELECTIVE-IV

MT/ME/MD 524/C :: QUALITY ENGINEERING

I Year M.Tech. (Machine Design) :: Second Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT-I

Quality value and Engineering: An overall quality system, quality engineering in production design, quality engineering in design production processes.
Loss function and quality level: Derivation and use of quadratile loss function, economic consequences of tightening tolerances as a means to improve quality, evaluations and types tolerances (N-type-, S-type and L-type)

UNIT-II

Tolerance Design and Tolerancing: Functional limits, tolerance design for N-type, L-type and S type characteristics, tolerance allocation for multiple components.
Parameter and tolerance design: Introduction to parameter design, signal to noise ratios, parameter design strategy, Introduction to tolerance design, tolerance design using the loss function, identification of tolerance design factors.

UNIT-III

Design of Experiments: Introduction, Task aids and Responsibilites for DOE process steps, DOE process steps description.
Analysis of variance (ANOVA): No-way ANOVA, One-way ANOVA, two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.
Orthogonal Arrays: Typical test strategies, better test strategies, efficient test strategies, conducting and analyzing an experiment.

UNIT-IV

Interpolation of experimental results: Interpretation methods, percent contribution, estimating the mean
ISO-9000 Quality system, BDRE,6-sigma, bench marking, quality circles-brain storming-fishbone diagram-problem analysis.

TEXT BOOKS:
1. Taguchi techniques for quality engineering/Philip J.Ross / McGraw Hill Intl. 2nd Edition,1995.

REFERENCES:
1. Quality Engineering in Production systems/G.Taguchi, A.Elasayed et al/Mc.Graw Hill Intl.Edition, 1989.
2. Taguchi methods explained: Practical steps to Robust Design/Papan P.Bagchi/Prentice Hall Ind. Pvt. Ltd. New Delhi.

ELECTIVE-V

MT/ME/MD 525/A :: GEAR ENGINEERING

I Year M.Tech. (Machine Design) :: Second Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

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.

Spur 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 II

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

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

UNIT III

Worm Gears: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of worm gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Heat dissipation considerations. Design of gear shaft and bearings.

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 IV

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.

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

Note: *PSG DATA BOOK ALLOWED*

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.

ELECTIVE-V

MT/ME/MD 525/B :: EXPERIMENTAL STRESS ANALYSIS

I Year M.Tech. (Machine Design) :: Second Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT – I

Introduction: Theory of Elasticity, Plane stress and plane strain conditions, Compatibility conditions. Problems using plane stress and plane strain conditions, Three-dimensional stress strain relations.

Strain Measurement Methods: Various types of strain gauges, Electrical Resistance strain gauges, semiconductor strain gauges, strain gauge circuits

Unit – II

Recording Instruments

Introduction, static recording and data logging, dynamic recording at very low frequencies, dynamic recording at intermediate frequencies, dynamic recording at high frequencies, dynamic recording at very high frequencies, telemetry systems.

Brittle coatings: Introduction, coating stresses, failure theories, brittle coating crack patterns, crack detection, ceramic based brittle coatings, resin based brittle coatings, test procedures for brittle coatings analysis, calibration procedures, analysis of brittle coating data.

Unit – III

Bi-refringent Coatings

Introduction, Coating stresses and strains, coating sensitivity, coating materials, application of coatings, effects of coating thickness, Fringe-order determinations in coatings, stress separation methods.

Moire Methods: Introduction, mechanism of formation of Moire fringes, the geometrical approach to Moire-Fringe analysis, the displacement field approach to Moire-Fringe analysis, out of plane displacement measurements, out of plane slope measurements, sharpening and multiplication of Moire-Fringes, experimental procedure and techniques.

Unit – IV

Photo elasticity: Photo elasticity – Polariscope – Plane and circularly polarized light, Bright and dark field setups, Photo elastic materials – Isochromatic fringes – Isoclinics

Three dimensional Photo elasticity : Introduction, locking in model deformation, materials for three-dimensional photo elasticity, machining cementing and slicing three-dimensional models, slicing the model and interpretation of the resulting fringe patterns, effective stresses, the shear difference method in three dimensions, applications of the Frozen-stress method, the scattered light method.

Text books :

1. Theory of Elasticity by Timoshenke and Goodier Jr
2. Experimental stress analysis by Dally and Riley,Mc Graw-Hill

References:

1. A treatise on Mathematical theory of Elasticity by LOVE .A.H
2. Photo Elasticity by Frocht

ELECTIVE-V

MT/ME/MD 525/C :: MECHANICS OF COMPOSITE MATERIALS

I Year M.Tech. (Machine Design) :: First Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT I

Introduction to Composite Materials: Definition, Classification, Types of matrices material and reinforcements, Characteristics & selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction.
Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Invariant properties. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

UNIT II

Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems.
Biaxial Strength Theories: Maximum stress theory, Maximum strain theory, Tsa-Hill theory, Tsai, Wu tensor theory, Numerical problems.

UNIT III

Macro Mechanical Analysis of Laminate: Introduction, code, Kirchoff hypothesis, CL T, A, B, and D matrices (Detailed derivation) Engineering constants, Special cases of laminates, Numerical problems.
Manufacturing: Lay up and curing - open and closed mould processing, Hand lay, Up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance, Introduction, material qualification, Types of defects, NDT methods.

UNIT IV

Application Developments: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites.
Metal Matrix Composites: Re-inforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications.

Text Books:
1. Composite Materials handbook, Mein Schwartz Mc Graw Hill Book Company, 1984.
2. Mechanics of composite materials, Autar K. Kaw CRC Press New York.
Reference Books:
1. Mechanics of Composite Materials, Rober M. Joness Mc-Graw Hill Kogakusha Ltd.
2. Stress analysis of fiber Reinforced Composite Materials, Michael W, Hyer MGH International.
3. Composite Material Science and Engineering, Krishan K. Chawla Springer.

ELECTIVE-VI

MT/ME/MD-526/A :: MECHATRONICS

I Year M.Tech. (Machine Design) :: Second Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT-I

Introduction : Introduction to Mechatronics - Systems - Mechatronics in Products - Measurement Systems - Control Systems -Traditional design and Mechatronics Design.

Sensors and Transducers : Introduction - Performance Terminology - Displacement, Position and Proximity - Velocity and Motion – Fluid pressure - Temperature sensors - Light sensors - Selection of sensors - Signal processing - Servo systems.

UNIT-II

Actuators and Drive systems : Mechanical, Electrical, hydraulic drive systems, Characteristics of mechanical, Electrical, Hydraulic and pneumatic actuators and their limitations.

System models: Mathematical models:- mechanical system building blocks, electrical system building blocks, thermal system building blocks, electromechanical systems, hydro-mechanical systems, pneumatic systems.

UNIT-III

Microprocessors in Mechatronics : Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085 instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters –Applications - Temperature control - Stepper motor control - Traffic light controller.

UNIT-IV

Programmable Logic Controllers : Introduction - Basic structure - Input / Output processing - Programming -Mnemonics Timers, Internal relays and counters - Data handling - Analog input / output - Selection of PLC.

Design and Mechatronics

Designing - Possible design solutions - Case studies of Mechatronics systems.

Text Books:

1. Michael B.Histand and David G. Alciatore, " Introduction to Mechatronics and Measurement
Systems", McGraw-Hill International Editions, 1999.
2. Bolton.W., “Mechatronics”, 2 Ed. Addison Wesley Longman, Pub, 1999
3. Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ., " Mechatronics ", Chapman and Hall,
1993.
4. Ramesh.S, Gaonkar, " Microprocessor Architecture, Programming and Applications ", Wiley Eastern,1998.
5. Lawrence J.Kamm, " Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics ",Prentice-Hall, 2000.
6. Ghosh, P.K. and Sridhar, P.R., 0000 to 8085, " Introduction to Microprocessors for Engineers and Scientists ", Second Edition, Prentice Hall, 1995.

ELECTIVE-VI

MT/ME/MD-526/B :: MECHANICS OF FRACTURE & FATIGUE

I Year M.Tech. (Machine Design) :: Second Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT I

Fracture mechanics principles: Introduction and historical review, Sources of micro and macro cracks. Stress concentration due to elliptical hole, Strength ideal materials, Griffith's energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics, Numerical problems.

The Airy stress function. Complex stress function. Solution to crack problems. Effect of finite size. Special cases, Elliptical cracks, Numerical problems.

UNIT II

Plasicity effects, Irwin plastic zone correction. Dugdale approach. The shape of the plastic zone for plane stress and plane strain cases, Plastic constraint factor. The Thickness effect, numerical problems. Determination of Stress intensity factors and plane strain fracture toughness: Introduction, analysis and numerical methods, experimental methods, estimation of stress intensity factors. Plane strain fracture toughness test, The Standard test. Size requirements. Non-linearity. Applicability.

UNIT III

The energy release rate, Criteria for crack growth. The crack resistance(R curve). Compliance, J integral. Tearing modulus. Stability.

Elastic plastic fracture mechanics : Fracture beyond general yield. The Crack-tip opening displacement. The Use of CTOD criteria. Experimental determination of CTOD.Parameters affecting the critical CTOD.Use of J integral. Limitation of J integral.

UNIT IV

Dynamics and crack arrest: Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crack branching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness.

Fatigue crack propagation and applications of fracture mechanics: Crack growth and the stress intensity factor. Factors affecting crack propagation. variable amplitude service loading, Means to provide fail-safety, Required information for fracture mechanics approach, Mixed mode (combined) loading and design criteria.

TEXT BOOKS:

1. Elementary Engineering Fracture Mechanics - David Brock, Noordhoff.
2. Fracture Mechanics-Fundamental and Application - Anderson, T.L CRC press1998.

REFERENCE BOOKS:

1. Engineering fracture mechanics - S.A. Meguid Elsevier.
2. Fracture of Engineering Brittle Materials, Applied Science - Jayatilake, London.
3. Fracture and Fatigue Control in Structures - Rolfe and Barsom, , Prentice Hall.
4. Introduction to fracture mechanics - Karen Hellan, McGraw Hill.
5. Fundamentals of fracture mechanisms - Knott, Butterworths. 6. Fracture –Liefbowitz Volime II.

ELECTIVE-VI

MT/ME/MD-526/C :: TRIBOLOGY

I Year M.Tech. (Machine Design) :: Second Semester

Lectures / Tutorials	*: 4 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

UNIT I

Introduction to Tribology: Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, lubrication theories. Newton's Law of viscous forces, Effect of pressure and temperature on viscosity.
Hydrodynamic Lubrication: Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems.

UNIT II

Hydrodynamic Bearings: Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, Numerical problems
Journal Bearings: Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommerfeld number and its significance. Comparison between lightly loaded and heavily loaded bearings, Numerical problems.

UNIT IIII

EHL Contacts: Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution. Introduction to gas lubricated bearings. Governing differential equation for gas lubricated bearings.
Hydrostatic Bearings: Types of hydrostatic Lubrication systems Expression for discharge, load carrying capacity, Flow rate, Condition for minimum power loss. Torque calculations. Numerical problems.

UNIT IV

Porous & Gas Bearings: Introduction to porous bearings. Equations for porous bearings and working principal, Fretting phenomenon and it's stages
Magnetic Bearings: Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings.

TEXT BOOKS:

1.Mujamdar.B.C "Introduction to Tribology of Bearing", Wheeler Publishing,New Delhi2001.
2. Susheel Kumar Srivasthava "Tribology in industry" S.Chand and Co.

REFERENCE BOOKS:

1. Dudley D.Fulier " Theory and practice of Lubrication for Engineers", New York CO.1998
2. Moore "Principles and applications of Tribology" Pergamon press.
3. Gerhand schwetizer, Hannes Bleuler & Alfons Traxler, "Active Magnetic bearings", Authors working group, www.mcgs.ch., 2003.
4. Radixmovsky, "Lubrication of Bearings - Theoretical principles and design" The Oxford press Company, 2000.

MT/ME/MD-561 :: MACHINE DYNAMICS LAB

I Year M.Tech. (Machine Design) :: Second Semester

Practicals	*: 6 Periods / week*	*Sessional Marks*	*: 30*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 70*

Any Ten Experiments should be performed:

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. Static balancing using steel balls
4. Determination of the magnitude and orientation of the balancing mass in dynamic balancing
5. To Perform an experiment on Dyanamic balancing on Dynamic balancing machine.
6. Determine the MI of connecting rod by compound pendulum method and tri flair suspension pendulum method
7. To study dynamically equivalent system
8. To study various types of dynamometers.
9. Determination of the magnitude of gyroscopic couple, angular velocity of precession, and representation of vectors.
10. Determination of natural frequency of given structure using FFT analyzer
11. Diagnosis of machine using FFT analyzer.
12. Direct kinematic analysis of a robot
13. Inverse kinematic analysis of a robot
14. Trajectory planning of a robot in joint space scheme.
15. Palletizing operation using Robot programming.
16. Simulation Exercises using MAT Lab
17. Simulation of Mass Dynamic System using MAT Lab

MT/ME/MD- 562 :: SEMINAR

I Year M.Tech. (Machine Design) :: Second Semester

Practicals	*: 6 Periods / week*	*Sessional Marks*	*: 100*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: --*

Internal assessment is done based on the seminar presentations.

MT/ME/MD-651 :: PROJECT SEMINAR

II Year M.Tech. (Machine Design) :: First Semester

Practicals	*: 24 Periods / week*	*Sessional Marks*	*: 100*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: --*

Internal assessment is done based on the seminar presentation.

MT/ME/MD 661 :: PROJECT VIVA

II Year M.Tech. (Machine Design) :: Second Semester

Practicals	*: 24 Periods / week*	*Sessional Marks*	*: 50*
University Exam.	*: 3 hrs.*	*University Exam. Marks*	*: 150*

Assessment is done based on the seminar presentations and Project viva-voce examination.