JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech in ENGINEERING DESIGN.
Effective from Academic Year 2017- 18 admitted batch

COURSE STRUCTURE AND SYLLABUS

I Semester

Category	Course Title	Int. marks	Ext. marks	L	T	P	C
PC-1	Advanced Mechanics of Solids	25	75	4	0	0	4
PC-2	Advanced Mechanics of Machinery	25	75	4	0	0	4
PC-3	Vibration Analysis of Mechanical Systems	25	75	4	0	0	4
PE-1	1. Computer Simulation of Machines 2. Design Optimization 3. Theory of Elasticity	25	75	**3**	0	0	3
PE-2	1. Advanced Mechanics of Composite Materials 2. Mechanics of Metal Forming 3. Design for Manufacturing & Assembly	25	75	**3**	0	0	3
OE-1	***Open Elective - I**	25	75	3	0	0	3
Laboratory I	Kinematics & Dynamics Lab	25	75	0	0	3	2
Seminar I	Seminar-I	100	0	0	0	3	2
Total		**275**	**525**	**21**	**0**	**6**	**25**

II Semester

Category	Course Title	Int. marks	Ext. marks	L	T	P	C
PC-4	Experimental Stress Analysis	25	75	4	0	0	4
PC-5	Advanced Finite Element Analysis	25	75	4	0	0	4
PC-6	Mechanical Behavior of Engineering Materials	25	75	4	0	0	4
PE-3	1. Industrial Robotics 2. Engineering Design 3. Fuzzy logic & Neural Networks	25	75	**3**	0	0	3
PE4	1. Vehicle Dynamics 2. Design and Analysis of Experiments 3. Structural Health monitoring	25	75	**3**	0	0	3
OE-2	***Open Elective - II**	25	75	3	0	0	3
Laboratory II	Computer Aided Testing , Analysis & Modelling Lab	25	75	0	0	3	2
Seminar II	Seminar-II	100	0	0	0	3	2
Total		**275**	**525**	**21**	**0**	**6**	**25**

III Semester

Course Title	Int. marks	Ext. marks	L	T	P	C
Technical Paper Writing	100	0	0	3	0	2
Comprehensive Viva-Voce	0	100	0	0	0	4
Project work Review II	100	0	0	0	22	8
Total	**200**	**100**	0	**3**	22	**14**

IV Semester

Course Title	Int. marks	Ext. marks	L	T	P	C
Project work Review III	100	0	0	0	24	8
Project Evaluation (Viva-Voce)	0	100	0	0	0	16
Total	**100**	**100**	**0**	**0**	**24**	**24**

***Open Elective subjects must be chosen from the list of open electives offered by OTHER departments.**

 # For Project review I, please refer 7.10 in R17 Academic Regulations.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech I Year – I Sem. (Engineering Design)

ADVANCED MECHANICS OF SOLIDS
(PC-1)

UNIT - I

SHEAR CENTRE: Bending axis and shear center-shear center for axi-symmetric and unsymmetrical sections.

Unsymmetrical bending: Bending stresses in Beams subjected to Nonsymmetrical bending; Deflection of straight beams due to nonsymmetrical 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 lads-stresses in chain links.

UNIT - III

TORSION: Torsion of a cylindrical bar of Circular cross Section; Saint-Venant's semi-inverse methods; Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section; Hallow thin wall torsion members, Multiply connected Cross section, Thin wall torsion members with restrained ends

Axi-Symmetric Problems: Rotating Discs – Flat discs, Discs of uniform thickness, Discs of Uniform Strength, Rotating Cylinders.

UNIT - IV

THEORY OF PLATES: Introduction; Stress resultants in a flat plate; Kinematics: Strain- Displacement relations for plates; Equilibrium equations for small displacement theory of flat plates; Stress – Strain – Temperature relation for Isotropic plates: Strain energy of a plate; Boundary conditions for plate; Solution of rectangular plate problem; Solution of circular plate problem.

Beams on Elastic Foundation: General theory; Infinite Beam subjected to concentrated load; boundary conditions; Infinite beam subjected to a distributed lad segment; Semi-infinite beam with concentrated load near its end; Short Beams.

UNIT - V

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

REFERENCES:

1. Advanced Mechanics of materials/Seely and Smith/ John Willey
2. Advanced Mechanics of materials / Boresi & Sidebottom/wiley international
3. Advanced strength of materials / Den Hortog J.P./Torrent
4. Theory of Plates /Timoshenko/
5. Strength of materials / Sadhu singh/ Khanna Publishers
6. Mechanics of Materials / Beer & Jhonson / McGraw Hill
7. Theory of Plates & Shells / Timoshenko/ McGraw Hill/ 2nd Edition

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech I Year – I Sem. (Engineering Design)

ADVANCED MECHANICS OF MACHINERY
(PC-2)

UNIT – I

ADVANCED KINEMATICS OF PLANE MOTION- I: Introduction to plane motion. The Inflection circle, Euler – Savary Equation, Analytical and graphical determination of d_i , Bobillier's Construction , Collineation axis , Hartmann's Construction ,Inflection circle for the relative motion of two moving planes, Application of the Inflection circle to kinematic analysis.

UNIT - II

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

UNIT – III

INTRODUCTION TO SYNTHESIS-GRAPHICAL METHODS - I: The Four bar linkage ,Guiding a body through Two distinct positions, Guiding a body through Three distinct positions, The Roto center triangle , Guiding a body through Four distinct positions, Burmester's curve.

UNIT - IV

INTRODUCTION TO SYNTHESIS-GRAPHICAL METHODS - II: Function generation- General discussion, Function generation: Relative – Roto center method, Overlay's method, Function generation- Velocity – pole method, Path generation: Hrones's and Nelson's motion Atlas, Roberts's theorem.

UNIT – V

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

REFERENCES:

1. Kinematics and Dynamics of plane mechanisms/ Jeremy Hirschhorn/McGraw-Hill, 1962.
2. Theory of Machines and Mechanisms/ J. E Shigley and J.J . Uicker Jr./ McGraw-Hill, 1995
3. Theory of Mechanisms and Machines/ Amitabh Ghosh and Ashok Kumar Mallik/ E.W.P. Publishers.
4. Kinematics and Linkage Design/ Allen S. Hall Jr./PHI, 1964.
5. Kinematics and Dynamics of Machinery/Charles E Wilson/Pearson/3rd Edition

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech I Year – I Sem. (Engineering Design)

VIBRATION ANALYSIS OF MECHANICAL SYSTEMS
(PC-3)

UNIT-I

SINGLE AND TWO DEGREE FREEDOM SYSTEMS: Response to Non Periodic Excitations: unit impulse, unit step and unit Ramp functions; response to arbitrary excitations, Principal modes-undamped and damped free and forced vibrations; undamped vibration absorbers.

UNIT-II

MULTI-DEGREE OF FREEDOM SYSTEMS: Introduction Modeling of Continuous systems as Multi-degree of Freedom systems, Using Newton's second law to derive equations of motion, Influence Coefficients. Potential and kinetic energy expressions in matrix form, Generalized coordinates and generalized forces, Using Lagrange's equations to derive equations of motion, Equations of motion of undamped systems in matrix form, Eigen value problem, solution of the Eigen value problems – solution of the characteristic equation, orthogonality of normal modes, repeated Eigen values.

UNIT- III

DETERMINATION OF NATURAL FREQUENCIES AND MODE SHAPES: Introduction, Dunkerley's formula, Rayleigh's Method- Properties of Rayleigh's Quotient, Computation of the Fundamental Natural Frequency, Fundamental Frequency of Beams and Shafts. Holzer's Method-Torsional systems, Spring Mass Systems. Jacobis method, Standard Eigen value Problems.

UNIT-IV

FREQUENCY DOMAIN VIBRATION ANALYSIS: Over view, machine-train monitoring parameters-Data base development-vibration data acquisition-trending analysis-failure- node analysis-signature analysis-root cause analysis.

UNIT-V

Vibration Control in Structures: Introduction, State space representation of equations of motion, Passive control, Active control and semi active control, Free layer and constrained damping layers, piezo electric sensors and actuators for active control, semi active control of automotive suspension systems.

REFERENCE:

1. Mechanical Vibrations/Groover /Nem Chand and Bros
2. Elements of Vibration Analysis by Meirovitch, TMH, 2001
3. Mechanical Vibrations/Schaum Series/ McGraw Hill
4. Mechanical Vibrations / SS Rao/ Pearson/ 2009, Ed 4,
5. Mechanical Vibrations/Debabrata Nag/Wiley
6. Vibration problems in Engineering / S.P. Timoshenko.
7. Mechanical Vibrations and sound engineering/ A.G. Ambekar/ PHI
8. Theory and Practice of Mechanical Vibrations/JS Rao& K. Gupta/New Age Intl. Publishers/Revised 2nd Edition

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech I Year – I Sem. (Engineering Design)

COMPUTER SIMULATIONS OF MACHINES
(PE-1)

UNIT- I

Introduction,Overview, Why Simulate Mechanisms, Kinematics Simulations, Dynamic Simulation of Mechanisms, Summary, Vector Loop and Vector Chain Equations – Introduction, The Planar Vector, Single Loop Equations, Derivatives of Vectors, Other Common Mechanisms, Vector Chains.

UNIT - II

SOLUTIONS OF THE POSITION PROBLEM: Overview, Numerical Solutions of Nonlinear algebraic Equations, The Position Problem of a Four-Bar Linkage, Mat lab Solution of the position of a Four-Bar Linkage.

UNIT- III

KINEMATIC SIMULATIONS USING SIMULINK: What is a Kinematic Simulation, Velocity Solution via Kinematic Simulation, Acceleration Solution via Kinematic Simulation, The Consistency Check, Kinematic Simulation of a Four-Bar Mechanism.

UNIT - IV

INTRODUCING DYNAMICS: Simulating the slider on inclined plane, Adding the Pendulum, Assembling the Matrix Equation, Creating a Dynamic Simulation, Setting Initial conditions and Running Simulation

UNIT - V

TWO-LINK PLANAR ROBOT: Overview, Vector Equations, Dynamic Equations, The Simultaneous Constraint matrix, Dynamic Simulation, Robot Coordinate Control.

REFERENCE:

1. Simulation Of Machines using Mat Lab and Simulink/John F. Gardner/
2. India Edition (IE)
3. CAD/CAM / Ibrahim zeid/ TMH.
4. Mat Lab / Raj Kumar Bansal / Pearson Education

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech I Year – I Sem. (Engineering Design)

DESIGN OPTIMIZATION
(PE-1)

UNIT- I:
General Characteristics of mechanical elements, adequate and optimum design, principles of optimization, formulation of objective function, design constraints, classification of optimization problems. Single and multivariable optimization techniques

UNIT-II:
Technique of unconstrained minimization.Golden section, Random, Patternand Gradient search methods, interpolation methods, equality and inequality constraints.

UNIT-III:
Direct methods and indirect methods using penalty function, Lagrange multipliers, Geometric programming, stochastic programming, Genetic algorithms

UNIT-IV:
Engineering applications, structural-design application axial and transverse loaded members for minimum cost, maximum weight.Design of shafts and torsion members, design optimization of springs.

UNIT-V:
Dynamics applications for two degree freedom system.vibration absorbers. Application in mechanisms.

REFERENCES:

1. Engineering Optimization -Theory and Practice/Singerusu S. Rao/ New Age.
2. Optimum Design of Mechanical elements/ Johnson Ray C/ Wiley, John & Sons
3. Genetic Algorithms in search, Optimization and Machine/ Goldberg D. E. Addison/Wesley / New York..
4. Optimization for Engineering Design Algorithms and Examples/ Kalyanamoy Deb/Prentice Flail of India.
   Introduction to Optimum Design/Jasbir S. Arora/ Academic Press/ Everest/ 3rd Edition

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech I Year – I Sem. (Engineering Design)

THEORY OF ELASTICITY
(PE-1)

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.

PROBLEMS IN POLAR COORDINATES - General equations in polar coordinates - Stress distribution symmetrical about axis - Strain components in polar coordinates - Simple and symmetric problems.

UNIT - II

ANALYSIS OF STRESS AND STRAIN IN THREE DIMENSIONS: Principle stresses - Homogeneous deformations - Strain spherical and deviatoric stress - Hydrostatic strain.

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

UNIT - III

BENDING OF PRISMATIC BARS: Stress function - Bending of cantilever beam - Beam of rectangular cross-section - Beams of circular cross-section.

UNIT - IV

Torsion: torsion of straight bars, Elliptic cross section, Membrane Analogy, torsion of a bar of narrow rectangular cross section, Torsion of rectangular bars, solution of torsional problems by energy method, Hydrodynamical Analogies, Torsion of hallow shafts, Torsion of thin tubes

UNIT - V

Axisymmetric stress and deformation in a solid of revolution: General equations, Solution by polynomials, Bending of a Circular plate, The rotating disc as a three dimensional problem, Pressure between two spherical bodies in contact, Pressure between two bodies in contact. More general care, symmetrical deformation of a circular cylinder, the circular cylinder with a band of pressure

REFERENCES:

1. Theory of Elasticity/Timoshenko S.P. and Goodier J.N./Koakusha Publishers
2. An Engineering Theory of Plasticity/E.P. Unksov/Butterworths
3. Applied Elasticity/W.T. Wang/TMH
4. Theory of Plasticity for Engineers/Hoffman and Sacks/TMH
5. Theory of Elasticity and Plasticity/Sadhu Singh/ Khanna Publishers
6. Theory of Elasticity and Plasticity/Harold Malcolm Westergaard/Harvard University Press

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech I Year – I Sem. (Engineering Design)

ADVANCED MECHANICS OF COMPOSITE MATERIALS
(PE-2)

UNIT – I

BASIC CONCEPTS AND CHARACTERISTICS: Geometric and Physical definitions, natural and man-made composites, Aerospace and structural applications, types and classification of composites.
Reinforcements: Fibres – Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetts, Metal matrix and ceramic composites.

UNIT – II

MICROMECHANICS: Unidirectional composites, constituent materials and properties, elastic properties of a lamina, properties of typical composite materials, laminate characteristics and configurations. Characterization of composite properties.
Manufacturing methods: Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion, RTM.

UNIT – III

COORDINATE TRANSFORMATION: Hooke's law for different types of materials, Hooke's law for two dimensional unidirectional lamina, Transformation of stress and strain, Numerical examples of stress strain transformation, Graphic interpretation of stress – strain relations. Off – axis, stiffness modulus, off – axis compliance.
Elastic behavior of unidirectional composites: Elastic constants of lamina, relationship between engineering constants and reduced stiffness and compliances, analysis of laminated composites, constitutive relations.

UNIT – IV

STRENGTH OF UNIDIRECTIONAL LAMINA: Micro mechanics of failure, Failure mechanisms, strength of an orthotropic lamina, strength of a lamina under tension and shear maximum stress and strain criteria, application to design. The failure envelope, first ply failure, free-edge effects.Micros mechanical predictions of elastic constants.

UNIT – V

ANALYSIS OF LAMINATED COMPOSITE PLATES:
Introduction thin plate theory, specially orthotropic plate, cross and angle ply laminated plates, problems using thin plate theory.

REFERENCES:

1. Mechanics of Composite Materials/ R. M. Jones/ McGraw Hill Company, New York, 1975.
2. Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.
3. Analysis and performance of fibre Composites/ B. D. Agarwal and L. J. Broutman/ Wiley-Interscience, New York, 1980.
4. Mechanics of Composite Materials/ Second Edition (Mechanical Engineering)/ Autar K. Kaw ,Publisher: CRC
5. Analysis of Laminated Composite Structures/ L. R. Calcote/ Van Nostrand Rainfold, New York, 1969.
6. Advanced Mechanics of Composite Materials/ Vasiliev & Morozov/Elsevier/Second Edition

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech I Year – I Sem. (Engineering Design)

MECHANICS OF METAL FORMING
(PE-2)

UNIT - I:
FUNDAMENTALS OF METAL FORMING: Classification of forming processes, mechanism of metal forming, temperature of metal working, hot working, cold working, friction and lubricants.
Rolling of metals: Rolling processes, forces and geometrical relationship in rolling, simplified analysis, rolling load, rolling variables, theories of cold and hot rolling, problems and defects in rolling, torque and power calculations.

UNIT - II:
FORGING: Classification of forging processes, forging of plate, forging of circular discs, open die and closed-die forging, forging defects, and powder metallurgy forging.
Extrusion: Classification, Hot Extrusion, Analysis of Extrusion process, defects in extrusion, extrusion of tubes, production of seamless pipes.

UNIT - III:
DRAWING: Drawing of tubes, rods, and wires: Wire drawing dies, tube drawing process, analysis of wire, deep drawing and tube drawing.
Sheet Metal forming: Forming methods, Bending, stretch forming, spinning and Advanced techniques of Sheet Metal Forming, Forming limit criteria, defect in formed parts.
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UNIT - IV:
ADVANCED METAL FORMING PROCESSES: HERF, Electromagnetic forming, residual stresses, in-process heat treatment, computer applications in metal forming.
Press tool design: Design of various press tools and dies like piercing dies, blanking dies, compound dies and progressive blanking dies, design of bending, forming and drawing dies.

UNIT - V:
JIGS AND FIXTURE DESIGN: Principles of location, six-point location principle, clamping elements and methods.

REFERENCES:
1. Mechanical Metallurgy / G.E. Dieter / Tata McGraw Hill, 1998. III Edition
2. Principles of Metal Working / Sunder Kumar
3. Principles of Metal Working processes / G.W. Rowe
4. ASM Metal Forming Hand book.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M. Tech I Year – I Sem. (Engineering Design)

DESIGN FOR MANUFACTURING AND ASSEMBLY
(PE-2)

UNIT - I:

INTRODUCTION: Design philosophy steps in Design process - General Design rules for manufacturability - basic principles of designing 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.

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 - III:

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 dies forging design - parting lines of dies drop forging die design - general design recommendations. Extrusion & Sheet Metal Work: Design guidelines for extruded sections - design principles for Punching, Blanking, Bending, Deep Drawing - Keeler Goodman Forming Line Diagram - Component Design for Blanking.

UNIT-IV

ASSEMBLE ADVANTAGES: Development of the assemble process, choice of assemble method assemble advantages social effects of automation.

AUTOMATIC ASSEMBLY TRANSFER SYSTEMS: Continuous transfer, intermittent transfer, indexing mechanisms, and operator - paced free – transfer machine.

UNIT-V:

DESIGN OF MANUAL ASSEMBLY: Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.

REFERENCES:

1. Assembly Automation and Product Design/ Geoffrey Boothroyd/ Marcel Dekker Inc., NY, 1992.
2. Engineering Design - Material & Processing Approach/ George E. Deiter/McGraw Hill Intl. 2nd Ed. 2000.
3. Hand Book of Product Design/ Geoffrey Boothroyd/ Marcel and Dekken, N.Y. 1990.
4. Computer Aided Assembly London/ A Delbainbre/.

5. Product Design for Manufacturing and Assembly/ Geoffrey Boothroyd, Peter Dewhurst & Winston Ansthony Knight/ CRC Press/2010
6. Design and Manufacturing / Surender Kumar & Goutham Sutradhar / Oxford & IBH Publishing Co. Pvt .Ltd., New Delhi, 1998.
7. ASM Handbook, Vol.20.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech I Year – I Sem. (Engineering Design)

KINEMATICS AND DYNAMICS LAB

(A Minimum of 10 experiments are to be conducted)
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. Static balancing using steel balls.
4. Determination of the magnitude and orientation of the balancing mass in dynamic balancing.
5. Field balancing of the thin rotors using vibration pickups.
6. Determination of the magnitude of gyroscopic couple, angular velocity of precession and representation of vectors.
7. Determination of natural frequency of given structure using FFT analyzer.
8. Diagnosis of a machine using FFT analyzer.
9. Direct Kinematic analysis of a robot.
10. Inverse Kinematic analysis of a robot.
11. Trajectory planning of a robot in joint space scheme.
12. Palletizing operation using Robot programming.