

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

M.Tech in MACHINE 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	Computer Aided Geometric Modeling for Design	25	75	4	0	0	4
PC-2	Mechanical Behavior of Engineering Materials	25	75	4	0	0	4
PC-3	Advanced Mechanics of Solids	25	75	4	0	0	4
PE-1	1. Design Optimization 2. Vibration Analysis of Mechanical Systems 3. Mechanics of Metal Forming	25	75	3	0	0	3
PE-2	1. Advanced Mechanics of Composite Materials 2. Design for Manufacturing & Assembly 3. Additive Manufacturing Technologies	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	Engineering Design	25	75	4	0	0	4
PC-5	Finite Element Analysis	25	75	4	0	0	4
PC-6	Analysis & Synthesis of Mechanisms	25	75	4	0	0	4
PE-3	1. Industrial Robotics 2. Product Design & Development 3. Fuzzy logic & Neural Networks	25	75	3	0	0	3
PE4	1. Design and Analysis of Experiments 2. Structural Health Monitoring 3. Vehicle Dynamics	25	75	3	0	0	3
OE-2	*Open Elective - II	25	75	3	0	0	3
Laboratory II	Computer Aided Testing , Analysis & Modeling 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.

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M. Tech I Year – II Sem. (Machine Design)

ENGINEERING DESIGN (PC - 4)

UNIT - I

DESIGN PHILOSOPHY: Design process, Problem formation, Introduction to product design, Various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations -standardization. Creativity, Creative techniques, Material selections, Notches and stress concentration, design for safety and Reliability

UNIT – II

Embodiment & Modelling: introduction, size and strength, scheme drawing, form design, provisional materials and process determination, design for assembly and manufacture, industrial design, principles. Mathematical modelling, optimization, scale models, simulation, principles.

UNIT - III

Economic Factors Influencing Design: Economic analysis, Break-even analysis, Human engineering considerations, Ergonomics, Design of controls, Design of displays. Value engineering, Material and process selection in value engineering, Modern approaches in design.

UNIT - IV

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

UNIT - V

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

Detail design: introduction, factor of safety, selection procedure for bought out components, Robust design, principles

REFERENCES:

1. Engineering Design / George E Dieter / McGraw Hill /2008
2. Engineering design principles/ Ken hurst/ Elsevier
3. Machine Design An Integrated Approach / Robert L. Norton / Prentice-Hall New Jersey, USA.
4. Engineering design process/ Yusef Haik, Tamer M. Shahin/ cengage learning.
5. Engineering by design/ Gerard Voland / pearson
6. Engineering design/ G. Pahl, W. Beitz, J, Feldhusen, K.H. grote/ springer international edition
7. Mechanical design/ Manjula B Waldron, Kenneth J. Waldron/ springer international edition
8. Product Design and Manufacturing /A. K. Chitale and R.C. Gupta / Prentice Hall

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FINITE ELEMENT ANALYSIS (PC - 5)

UNIT - I:

Introduction to FEM, basic concepts, historical back ground, applications of FEM, general description, comparison of FEM with other methods, variational approach, Galerkin's Methods. Co-ordinates, basic element shapes, interpolation function, Virtual energy principle, Rayleigh – Ritz method, properties of stiffness matrix, treatment of boundary conditions, solution of system of equations, shape functions and characteristics, Basic equations of elasticity, strain- displacement relations.

UNIT - II:

1-D Structural Problems: Axial bar element – stiffness matrix, load vector, temperature effects, Quadratic shape functions, and problems.

Analysis of Trusses: Plane Trusses and Space Truss elements and problems

Analysis of Beams: Hermite shape functions – stiffness matrix – Load vector – Problems.

UNIT - III:

2-D Problems: CST, LST, force terms, Stiffness matrix and load vectors, boundary conditions, Isoparametric elements – quadrilateral element, shape functions – Numerical Integration. Finite element modelling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements.

Problems: Tetrahedron element – Jacobian matrix – Stiffness matrix.

UNIT- IV:

Scalar Field Problems: 1-D Heat conduction-Slabs – fins - 2-D heat conduction problems – Introduction to Torsional problems.

UNIT - V:

Dynamic considerations, Dynamic equations – consistent mass matrix – Eigen Values, Eigen vector, natural frequencies – mode shapes – modal analysis.

REFERENCES:

1. The Finite Element Methods in Engineering / SS Rao /Pergamon.
2. Finite Element Methods: Basic Concepts and applications, Alavala, PHI
3. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu, Prentice – Hall
4. Finite Element Method – Zienkiewicz / McGraw Hill
5. Introduction to Finite element analysis- S. Md. Jalaludeen, Anuradha Publications, print-2012
6. A First Course in the Finite Element Method/Daryl L Logan/Cengage Learning/5th Edition
7. Finite Element Method – Krishna Murthy / TMH
8. Finite Element Analysis – Bathe / PHI

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ANALYSIS AND SYNTHESIS OF MECHANISMS (PC-6)

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. Design of machinery / Robert L Norton third edition/ McGraw-Hill 2004
4. Theory of Mechanisms and Machines/ Amitabh Ghosh and Ashok Kumar Mallik/ E. W. P. Publishers.
5. Kinematic Linkage Design/ Allen S.Hall Jr./ PHI,1964.
6. Kinematics and Dynamics of Machinery/Charles E Wilson/Pearson/3rd Edition

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INDUSTRIAL ROBOTICS (PE- 3)

UNIT - I:

Introduction: Automation and Robotics, Robot anatomy, robot configuration, motions joint notation work volume, robot drive system, control system and dynamic performance, precision of movement.

Control System and Components: basic concept and modals controllers control system analysis, robot actuators and feedback components (sensors): Internal & External Sensors, Positions sensors, velocity sensors - Desirable features, tactile, proximity and range sensors, uses sensors in robotics , Power Transmission Systems.

UNIT - II:

Motion Analysis and Control: Manipulator kinematics, position representation Homogeneous transformation, D-H Notation, D-H Transformation Matrix, Forward & Inverse transformations, problems on planar & spatial manipulators, Differential Kinematics, Jacobian Formulation, problems, manipulator path control: Slew, Joint Interpolated & Straight line motions, trajectory planning: Joint space scheme, Cartesian space scheme, Cubic Polynomial fit without and with via point, blending.

UNIT - III:

Robot Dynamics: Lagrange – Euler & Newton Euler formulations, problems on two link planar manipulators, configuration of robot controller.

End Effectors: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design.

Machine Vision: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog to digital single conversion, Image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.

UNIT - IV:

Robot Programming: Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SIGNAL AND DELAY commands, Branching capabilities and Limitations.

Robot Languages: Textual robot languages, Generation, Robot language structures, Elements and functions.

UNIT - V:

Robot Cell Design and Control: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work cell design, Work cell control, Inter locks, Error detection, Work cell controller.

Robot Applications: Material transfer, Machine loading/unloading. Processing operations, Assembly and Inspection, Future Applications.

REFERENCE BOOKS:

1. Introduction to Robotics Mechanics & Control/ John J.Craig/Pearson
2. Industrial robotics / Mikell P. Groover / McGraw Hill.
3. Modelling & Ctrl of Robot Manipulators/L. Sciavicco & B. Siciliano/Springer
4. Robot Technology Fundamentals, James G. Keramas, CENGAGE
5. Robotics / K.S. Fu / McGraw Hill.
6. Robot Analysis/Lung Wen Tsai/John Wiley & Sons
7. Robotics & control/R K Mittal & I J Nagrath/ Tata McGraw Hill
8. Fundamentals of Robotics/Robert J. schilling/PHI
9. Robotics by saha/TMG
10. Robotic Engineering/ Richard D. Klafter, Thomas A. Chmielewski/PHI

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Product Design and Development (PE - 3)

UNIT - I

Introduction: Need for IPPD – strategic importance of product development – integration of customer, designer, material supplier and process planner, Competitor and customer – behavior analysis

Understanding customer – promoting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specification.

UNIT - II

Concept generation and concept selection: Activity of concept generation – Structured approaches – Five step Method: clarify – Search-Externally and internally – explore systematically – reflect on the solutions and processes – **Concept selection** – Integral part of PDD process-methodology – benefits.

UNIT - III

Product architecture: Implications – Product change – variety – component standardization – Product performance – manufacturability

Industrial design: Assessing the need for industrial design, impact – design process

Integrate design process – assessing the quality of industrial design.

ROBUST DESIGN - introduction, various steps in robust design.

UNIT - IV

Investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

UNIT – V

Design for manufacturing: Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs –cost of supporting production. Minimizing System complexity.

Prototyping: Prototype basics – Principles of prototyping – planning for prototypes – Economic analysis. Understanding and representing tasks – baseline project planning– accelerating the project execution.

REFERENCE BOOKS:

1. Product Design and Development / Kari T. Ulrich and Steven D. Eppinger / McGraw Hill International Edns. 1999.
2. Effective Product Design and Development / Stephen Rosenthal / Business One Orwin, Homewood, 1992, ISBN, 1-55623-603-4.
3. Concurrent Engg/ integrated Product development / Kenneth Crow / DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274(310)377-569, Workshop Book.
4. Tool Design – Integrated Methods for Successful Product Engineering / Stuart Pugh / Addison Wesley Publishing, New York, NY, 1991, ISBN 0-202-41639-5.

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FUZZY LOGIC & NEURAL NETWORKS (PE - 3)

UNIT - I

Fuzzy Set Theory and Fuzzy Logic Control:

Basic concepts of fuzzy sets- Operations on fuzzy sets- Fuzzy relation equations- Fuzzy logic control- Fuzzification –Defuzzification- Knowledge base- Decision making logic- Membership functions – Rule base.

UNIT - II

Adaptive Fuzzy Systems:

Performance index- Modification of rule base- Modification of membership functions- Simultaneous modification of rule base and membership functions- Genetic algorithms- Adaptive fuzzy system- Neuro fuzzy systems.

UNIT - III

Artificial Neural Networks:

Introduction- History of neural networks- multilayer perceptions- Back propagation algorithm and its Variants- Different types of learning, examples.

UNIT - IV

Mapping and Recurrent Net works:

Counter propagation –Self organization Map- Cognitron and Neocognitron- Hopfield Net- Kohonen Nets- Grossberg Nets- Art-I, Art-II reinforcement learning

UNIT - V

Case Studies:

Application of fuzzy logic and neural networks to Measurement- Control- Adaptive Neural Controllers – Signal Processing and Image Processing

TEXT BOOK:

1. Vallum B.R And Hayagriva V.R C++, Neural networks and Fuzzy logic, BPB Publications, New Delhi, 1996

REFERENCE BOOKS:

1. Fuzzy logic & Neural Networks/ Chennakesava R. Alavala/ New Age International, 2008
2. Neural Networks for control, Millon W. T, Sutton R.S and Werbos P. J, MIT Press 1992
3. Fuzzy sets Fuzzy logic, Klir, G. J and Yuan B.B Prentice Hall of India Pvt. Ltd., New Delhi
4. Neural Networks and Fuzzy systems, Kosko.. Prentice hall of India Pvt. Ltd., New Delhi 1994
5. Introduction to Fuzzy control, Dirankov D. Hellendoorn H, Reinfrank M., Narosa Publications House, New Delhi 1996
6. Introduction to Artificial Neural systems, Zurada J. M Jaico Publishing House, New Delhi 1994

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DESIGN AND ANALYSIS OF EXPERIMENTS (PE - 4)

UNIT - I:

Fundamentals of Experimentation: Role of experimentation in rapid scientific progress, historical perspective of experimental approaches, Steps in experimentation, principles of experimentation

UNIT - II:

Simple comparative experiments: Basic concepts of probability & statistics, comparison of two means and two variances, comparison of multiple (more than two) means and ANOVA

UNIT - III:

Experimental designs: Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays and interaction tables, modifying orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data

UNIT - IV:

Response surface methodology: Concept, linear model, steepest ascent, second order model, regression.

UNIT - V:

Taguchi's Parameter Design: Concept of robustness, noise factor, objective function & S/N ratios, inner array & outer array design, data analysis

REFERENCE BOOKS:

1. Montgomery DC, Design and Analysis of Experiments, 7th Edition, John Wiley & Sons, NY, 2008.
2. Ross P J , Taguchi techniques for Quality Engineering, McGraw-Hill Book Company, NY, 2008

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STRUCTURAL HEALTH MONITORING (PE - 4)

UNIT - I:

Introduction: Definition, Principles, significance of SHM, potential applications in civil, naval, aerospace & manufacturing Engineering

UNIT - II:

Operational Evaluation: Sensor technology, piezoelectric wafer active sensors, data acquisition and cleaning procedures, elastic waves in solid structures, guided waves

UNIT - III:

Feature Extraction methods: Identifying damage sensitive properties , signal processing, Fourier and short term Fourier transform, wavelet analysis

UNIT- IV:

Pattern Recognition: State-of-Art damage identification and pattern reorganization methods, neural networks, Feature extraction algorithms

UNIT - V:

Case studies: SHM based flaw detection in mechanical structures- Integrity and damage recognition in plates and pipes, defect identification in weld joints, Wear monitoring in cutting tools

REFERENCE BOOKS:

1. Daniel Balageas, Claus-Peter Fritzen and Alfredo Guemes, Structural Health Monitoring, John Wiley & Sons, 2006.
2. Victor Giurgiutiu, Structural Health Monitoring with Piezoelectric wafer Active Sensors, Academic Press, 2008.

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VEHICLE DYNAMICS (PE - 4)

UNIT - I:

Introduction: Fundamental Principles, Vehicle tires performance, cornering characteristics, Mechanics of Vehicle Terrain interaction. Vehicle Kinematics, Fundamental principles of velocity, acceleration. Two dimensional mechanisms, Forward Vehicle Dynamics.

UNIT - II:

Three dimensional Mechanisms, Multi-Body Systems Design, Introduction to 3D vehicle design.

UNIT - III:

Suspension Design: Computer models using Bond Graph Technology, Drive train dynamics, vehicle performance

UNIT - IV:

Steering Mechanisms: Two and three dimensional analysis, Mechanics of Vehicle Terrain interaction. Vehicle Collations, Fundamental laws of motion, energy and momentum, Forces and Moments 2D and 3D. The Dynamics of vehicle rollovers.

UNIT - V:

Wheeled Vehicle Handling – Handling control loop, vehicle transfer function, Kinematic behavior of vehicles with rigid wheels and with complaint tyres: Neutral steer point, static margin, over and under-steer. Solution with two degree of freedom in the steady state: Stability factor, characteristic and critical speeds. Tracked Vehicle Handling – Analysis of sprocket torques and speeds, required to skid steer a tracked vehicle. Extension of theory to include three degrees of freedom.

REFERENCE:

1. Vehicle Dynamics: Theory and Application/Reza Jazar/Springer 2008
2. Theory of Ground Vehicles/ J. Y. Wong/ John Wiley.
3. Vehicle stability/ Dean Karnopp/ Dekker Mechanical Engineering
4. Modeling & Simulation of Mechatronics Systems/ Karnoop Margolis, Rosenberg, /Wiley/ 2007.
5. Suspension and Tyres / Giles J.G. Steering/ Illiffe Books Ltd., London.
6. Fundamental of Vehicle Dynamics/ Gillespie/ T.D, SAE USA.

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COMPUTER AIDED TESTING, ANALYSIS AND MODELLING LAB

TESTING

1. Preparation and study of the Micro Structure of ferrous metals and alloys.
2. Preparation and study of the Microstructure of nonferrous metals and alloys.
3. Effect of tempering time on the hardness of quenched carbon steels.
4. Effect of tempering temperature on the hardness of a hardened carbon steels.
5. Preparation of metallic specimens by electro polishing.
6. Study of work hardening characteristics of a pure metal.
7. Determination of carbon percentage in the given ferrous specimen.

MODELING

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

ANALYSIS OF STRUCTURES USING FEA PACKAGES

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