ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: School of Mechanical Sciences
Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

Abbreviation used:

AC	Audit course	LC	Lab Course	PA	Practical Assessment
PC	Professional Core	PR	Project/ Practical/ Internship	L	Lecture
PE	Professional Elective	SE	Seminar/ Expert Lecture/ Etc.	T	Tutorial
OE	Open Elective	IA*	Internal Assessment	P	Practical
MC	Mandatory/ Common Course	EA	End-Semester Assessment		

Subject Code Format:

A1	A2	B3	C4	C5	C6
School/ Dept. (Offering) **BH:** Basic Sciences and Humanities **CS:** Computer Sciences **EE:** Electrical Sciences **EI:** Electronic Sciences **IP:** Infrastructure and Planning **MS:** Mechanical Sciences **BT:** Biotechnology **TE:** Textile Engineering		**Level** **1:** UG/ Int. Msc. (1st Year) **2:** UG/ Int. Msc. (2nd Year) **3:** UG/ Int. Msc. (3rd Year) **4:** UG/ Int. Msc. (4th Year) **5:** UG/ Int. Msc. (5th Year) **6:** PG (1st Year) **7:** PG (2nd Year) **8:** Ph.D.	**0:** AC **1:** PC **2:** PE **3:** OE **4:** MC **5:** LC **6:** PR **7:** SE **8:** **9:**	**Serial Number (01 to 99)** 01/ 03/…/ 19: Odd Sem. (IEM) 21/ 23/…/ 39: Odd Sem. (MML) 41/ 43/…/ 59: Odd Sem. (MSD) 61/ 63/…/ 79: Odd Sem. (THE) 81/ 83/…/ 99: Odd Sem. (MBA) 02/ 04/…/ 20: Even Sem. (IEM) 22/ 24/…/ 40: Even Sem. (MML) 42/ 44/…/ 60: Even Sem. (MSD) 62/ 64/…/ 80: Even Sem. (THE) 82/ 84/…/ 98: Even Sem. (MBA)	

1st Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC 1	MS6141	Advance Synthesis of Mechanism	3	0	0	3	40	60	-	100
2	PC 2	MS6143	Advanced Mechanics of Solid	3	0	0	3	40	60	-	100
3	PE 1 (Any One)	MS6241	Applied Finite Element Analysis	3	0	0	3	40	60	-	100
		MS6243	Fatigue, Creep & Fracture								
		MS6245	Tribology								
		MS6247	Design of Experiments								
4	MC 1	BH6401	Mathematical Methods in Engineering	3	0	0	3	40	60	-	100
5	MC 2	MS6403	Research Methodology and IPR	2	0	0	2	40	60	-	100
6	LC 1	MS6541	Mechanical Systems Simulation Lab	0	0	4	2	-	-	100	100
7	LC 2	MS6543	Experimental Techniques for Mechanical Engineers	0	0	4	2	-	-	100	100
8	AC 1	Any One from the List of AC 1 (Appendix-I)		2	0	0	0	40	60	-	100
			Total	**16**	**0**	**8**	**18**	**240**	**360**	**200**	**800**

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2nd Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC 3	MS6142	Advanced Mechanical Vibration	3	0	0	3	40	60	-	100
2	PC 4	MS6144	Dynamics and Control of Mechanical Systems	3	0	0	3	40	60	-	100
3	PE 2 (Any One)	MS6242	Computational Techniques for Mechanical Systems	3	0	0	3	40	60	-	100
		MS6244	Acoustics and Noise Control								
		MS6246	Applied Ergonomics								
		MS6248	Rotor Dynamics								
4	PE 3 (Any One)	MS6250	Composite Materials	3	0	0	3	40	60	-	100
		MS6252	Engineering Design Optimization								
		MS6254	Engineering Measurements								
		MS6256	Robotics and Automation								
5	OE 1	Any One from the List of OE 1 (Appendix-I)		3	0	0	3	40	60	-	100
6	PR 1	MS6642	Project (Specialization Related)	0	0	4	2	-	-	100	100
7	LC 3	MS6542	Computational Techniques for Mechanical Systems Lab	0	0	4	2	-	-	100	100
8	AC 2	Any One from the List of AC 2 (Appendix-I)		2	0	0	0	40	60	-	100
			Total	**17**	**0**	**8**	**19**	**240**	**360**	**200**	**800**

3rd Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PE 4* (Any One)	MS7241	Robot Mechanics and Control	3	0	0	3	40	60	-	100
		MS7243	Sensors and Actuators in Industry								
		MS7245	Artificial Intelligence								
		MS7247	Fundamentals of Mechatronics								
2	PR 2	MS7641	Dissertation (Phase-I)	0	0	24	12	-	-	100	100
			Total	**3**	**0**	**24**	**15**	**40**	**60**	**100**	**200**

* Virtual/Online Course either offered by OUTR or available in MOOCs platform (No physical class)

4th Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PR 3	MS7642	Dissertation (Phase-II)	0	0	32	16	-	-	100	100
			Total	**0**	**0**	**32**	**16**	**-**	**-**	**100**	**100**

Credits and Maximum Marks

Sl. No.	Semester	Credits	Maximum Marks
1	1st	18	800
2	2nd	19	800
3	3rd	15	200
4	4th	16	100
	Total	68	1900

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1st Semester

PC 1	MS6141	Analysis and Synthesis of Mechanism	3	0	0	3

Module I

Introduction: Review of fundamentals of kinematics – mobility analysis –D.O.F. – mixed mobility, total partial and fractional DOF, multi loop kinematic chains.

Kinematic Analysis: Basic concepts of kinematics and mechanisms-type, number and dimensions, kinematic pairs, chains and inversions, accuracy point and error analysis, velocity and acceleration analysis of different complex mechanism.

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, twin cylinder engine.

Module II

Synthesis of Mechanisms: Type, Number and Dimensional Synthesis; Function generation, path generation and body guidance; two-position synthesis of slider crank mechanism; two-position synthesis of crank and rocker mechanism; crank-rocker mechanisms with optimum transmission angle; three position synthesis; four-position synthesis, point precision reduction; Precision position; structural error; Chebychev spacing; the Overlay method; copular curves synthesis; Cognate linkages – The Roberts-Chebychev Theorem; Bloch's Method of Synthesis; Freudenstein's equation; Inflection Circle and Euler -Savary equation; Center -point and center-point Circles, The Inflection circle for the relative motion of two moving planes.

Introduction to Spatial Mechanisms and Robotics: Vector methods in plane kinematics, Matrix Methods in Kinematics, analysis of space mechanisms, Kinematic analysis of spatial RSSR mechanism – Denavit – Hartenberg parameters – Forward and Inverse kinematics of robotic manipulators.

Module III

Cam Mechanism: Synthesis of cam profiles, Analysis of follower motion, Analysis of Cam Design, Practical Design Consideration

Mechanism Trains: Parallel Axis Gear Trains; Epicyclic Gear Trains; Bevel Gear Epicyclic Trains; Analysis of Planetary Gear Trains; Adders and Differentials; All Wheel Drive Train

Balancing: Balancing Linkages – Complete Force Balancing of Linkages; Effect of Balancing on Shaking and pin Forces; Effect of Balancing on Input Torque; Balancing of I-C engines.

Text Books:

1. A. Ghosh & A.K. Mallik, *Theory of Mechanism &Machines*, Affiliated East-West Press: 1998
2. R.S. Hartenberg& J. Denavit, Kinematic Synthesis of Linkages, TMH, New York, 1964.
3. A. S. Hall (Jr.): Kinematics and linkage Design, Prentice Hall, Englewood Cliffs, New Jersey.
4. Theory of Machines and Mechanisms, Shigley J. E., Pennock G.R., and Uicker J.J. Oxford.

Reference Books:

1. Kinematic and Dynamics of Machinery: Norton R. L., TMH
2. Advaced Mechanism Design: Analysis and Synthesis, Sandor G.N. and Erdman A.G. PHI
3. Mechanism Design, Vol –1 & II, George N Sandor and Arthur G Erdman, PHI
4. Mechanism and Machines (Analysis & Synthesis) Arthur G Erdman, PHI
5. Robotics Technology and Flexible Automation, Deb S. R., TMH

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PC 2	MS6143	Advanced Mechanics of Solid	3	0	0	3

Modules - I

Elementary concept of elasticity, stresses in three dimensions, Principal Stresses, Stress Invariants, Mohr's Circle for 3-D state of stress, Octahedral Stresses, State of pure shear, Differential equations of equilibrium and compatibility conditions, plane stress. Analysis of strain, State of strain at a point, Strain Invariant, Principal Strains, Plane state of strain, Strain measurements. Theories of Failure, Various yield criteria

Modules - II

Energy Methods: Work done by forces and elastic strain energy stored. Reciprocal relations, Theorem of virtual work, Castigliano's theorems, bending of beams: Asymmetrical bending, Shear center, Bending of curved beams, Stress distribution in beam with rectangular, circular and trapezoidal cross section, stresses in crane hooks, ring and chain links., Deflection of thick curved bars. Axisymmetric problems: Thick walled cylinder subjected to internal and external pressures, Compound cylinders, Shrink fit

Modules - III

Repeated stresses and fatigue in metals, Fatigue tests and fatigue design theory, Goodman, Gerber and Soderberg criteria, Concept of stress concentration, Notch sensitivity. Introduction to Mechanics of Composite Materials: Lamina and Laminates, Micromechanics of FRP Composites. Introduction to Fracture Mechanics: Basic modes of fracture, Fracture toughness evaluation.

Text Book:

1. Advanced Mechanics of Solids, L.S. Srinath, Tata McGrawHill
2. Advanced Mechanics of Materials: Boresi and Schmdt,Willey
3. Strength of Materials by G. H. Ryder, MacmillanPress

Reference Book:

1. Advanced Mechanics of Materials: SileyandSmith
2. Strength of Materials Vol.II, byS.Timoshenko
3. Mechanics of Materials by Beer and Johnston, Tata McGrawHill
4. Mechanics of Materials by R.C.Hibbeler, PearsonEducation
5. Mechanics of Materials by William F.Riley, Leroy D.Sturges& Don H.Morris, WileyStudent.
6. Mechanics of Materials by James M. Gere, ThomsonLearning
7. Strength of Materials by S. S. Rattan, Tata Mc GrawHill

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PE 1	MS6241	Applied Finite Element Analysis	3	0	0	3

Module I

Introduction to Finite Element Method: Basic Steps in Finite Element Method to solve mechanical engineering (Solid, Fluid and Heat Transfer) problems: Functional approach and Galerkin approach, Displacement Approach: Admissible Functions, Convergence Criteria: Conforming and Non-Conforming elements, Co, $C_1$and Cn Continuity Elements. Basic Equations, Element Characteristic Equations, Assembly Procedure, Boundary and Constraint Conditions

One-Dimensional Finite Element Formulations and Analysis in Solid Mechanics for Bars (uniform, varying and stepped cross section). Basic(Linear) and Higher Order Elements Formulations for Axial, Torsional and Temperature Loads. (Linear) Element Formulation for uniform, varying and stepped cross section, for different loading and boundary conditions with problems. Trusses, Plane Frames and Space Frame Basic(Linear) Elements Formulations for different boundary condition in Axial, Bending, Torsional, and Temperature Loads.

Module II

Two-Dimensional Finite Element Formulations for Solid Mechanics Problems: Triangular Element, Four-Noded Quadrilateral Element Formulations for in-plane loading. Triangular and Quadrilateral Axi-symmetric basic and higher order Elements formulation for axi-symmetric loading.

Description about Three-Dimensional Finite Element Formulations for Solid Mechanics Problems: Finite Element Formulation of Tetrahedral Element and Hexahedral Element for different loading conditions. Serendipity and Lagrange family Elements.

Module III

Finite Element Formulations for Structural Mechanics Problems: Basics of plates and shell theories: Classical thin plate Theory, Shear deformation Theory and Thick Plate theory. Finite Element Formulations for triangular and quadrilateral Plate elements.

Dynamic Analysis: Finite Element Formulation for point/lumped mass and distributed masses system, Finite Element Formulation of one-dimensional dynamic analysis: bar and beam element. Finite Element Formulation of Two-dimensional dynamic analysis: triangular, quadrilateral and axisymmetric element. Evaluation of eigen values and eigen vectors applicable to bars, shaft, beams.

Text Books:

1. T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall,

Reference Books:

1. Concepts and Applications of Finite Element Analysis", (4th edition), by Cook, Robert Davis et al", Wiley, John & Sons
2. A first course in the finite element method" (4th edition), by Daryl L. Logan, Cengage Learning India
3. J.N.Reddy, Introduction to Finite Element Method, McGraw -Hill,
4. Bathe K. J., Finite Element Procedures, Prentice-Hall,.
5. Cook R. D., Finite Element Modeling for Stress Analysis, Wiley,1995.

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PE 1	MS6243	Fatigue, Creep & Fracture	3	0	0	3

Module-I

Fatigue: Types of fatigue loading and failure, Fatigue test, endurance limit; Fatigue under combine stresses; Influence of stress concentration on fatigue strength, Notch sensitivity, Factors influencing fatigue behavior.

Module-II

Creep: Creep-stress-time temperature relations, Mechanics of creep in tension, bending, torsion, creep buckling. Members subjected to creep and combined stresses.

Module-III

Fracture: Basic modes of fracture, Griffith of brittle fracture, Irwin's theory of fracture in elastic-plastic materials. Theories of linear elastic fracture mechanics, stress intensity factors, fracture toughness testing.

Text Books:

1. Strength and Resistance of Metals - J. M. Lessels, John Wiley and Sons, Inc., 1954.
2. Mechanical Behaviour of Engineering Materials - Joseph Marin, PHI, 1966.
3. Fatigue Testing and Analysis - Y. Lee, J.Pam, R.B. Hathaway & M.E. Barkey Elsevier Press
4. Engineering Fracture Mechanics - S. A. Meguid, Elsevier Press, 1989.
5. Mechanical Metallurgy - G. E. Dieter, Mc-Graw Hill Book Co., 1961.
6. Mechanical Behaviour of Materials - N. E. Dowling, PHI, 1997.
7. Introduction to Fracture Mechanics - KareHellan, Mc-Graw Hill Book Co., 1985.
8. The Practical Use of Fracture Mechanics - David Broek, MN Publishers, 1982.

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PE 1	MS6245	Tribology	3	0	0	3

Module I

Tribology, Historical background, practical importance and subsequent use in the field. **Lubricants:** Types and specific field of applications. Requisite properties of lubricants. Viscosity, its measurement, effect of temperature and pressure on viscosity, standard grades of lubricants, selection of lubricants. Lubricant Rheology, Lubrication Types, Basic equation of lubrication. **Friction:** Origin, Friction Theories, measurement methods, friction of metals and non-metals.

Wear: Classification and Mechanisms of Wear, Delamination theory, Debris analysis, testing methods and standards, wear mechanism maps and approach to wear reduction.

Related Case Studies.

Module II

Surface Roughness: Standardization, measurement with contacting and non-contacting instruments, Statistical analysis of surface, characteristics of the surface, tribological behaviour of asperities contact.

Behaviour of Tribological components:

Plain & Antifriction Bearings: selection, effect of frictional torque, factors affecting performance, failure modes, bearing lubrication.

Gears: friction & stresses, wear, lubrication & failure. Failure Case Studies.

Hydrodynamic Bearings: Mechanism of pressure development, classification, Idealized Journal Bearing, oil film thickness, pressure distribution, load carrying capacity. Failure Case Studies.

Elastohydrodynamic Lubrication: Theoretical considerations, line and point contacts, film thickness equations, different regimes in EHL contact.

Module III

Antifriction Bearings: Ball and roller bearings, geometry of ball bearings, radial load distribution, stresses and deformations, lubrication of ball bearings. Failure Case Studies.

Monitoring of Equipment's Condition: Condition monitoring techniques, lubricant, corrosion, temperature &surface roughness monitoring. Failure Case Studies.

Nano/Micro Tribology, Green Tribology.

Text Books:

1. Engineering Tribology– PrasantaSahoo – Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
2. Fundamentals of Tribology – S.K. Basu, S.N. Sengupta, B.B. Ahuja – PHI Learning Pvt. Ltd., 2010.
3. Tribology in Industries – S.K. Shrivastava – S. Chand & Company Ltd., New Delhi, 2001
4. Bearing Design in Machinery, Engineering Tribology and Lubrication - A. Harnoy- Marcel Dekker Inc., 2003Experimental Stress Analysis – J. W. Dally and W. F. Riley. McGrawHill, 1965.

Reference Books:

1. Engineering Tribology – G.W. Stachowiak, A.W. Batchelor – Elsevier India Pvt. Ltd., New Delhi.
2. Introduction to Tribology of Bearings – B.C. Majumdar – S. Chand & Company Ltd., New Delhi.
3. Rolling Bearing Analysis – T.A. Harris – John Wiley & Sons, Inc., New York
4. Engineering Tribology – J. Williams - Cambridge University Press, 2004.xperimental Stress Analysis and Motion Measurement – R. C. Dove and P. H. Adams. PHI, 1965.
5. Applied Stress Analysis – A. J. Durelli. PHI, 1970.

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PE 1	MS6247	Design of Experiments	3	0	0	3

Module - I

Introduction to Designed Experiments: Strategy of experimentation, Typical applications, Basic principles and guidelines for designing experiments, Basic statistical concepts: Descriptive Statistics, Sampling and Sampling Distributions, Tests of Hypotheses,

Module - II

Single factor experiments with Fixed Effects: ANOVA, Model Adequacy Tests, Orthogonal Contrasts, Experiments with Blocking Factors: Randomised Complete and Incomplete Block Designs, Latin Squares Design, Factorial Experiments: 22, 32, and 2k Designs, Blocking and Confounding, and Fractional Factorial Designs, Linear Regression Models: Estimation of Parameters, Tests of Hypothesis, Regression Model Diagnostics.

Module - III

Response Surface Design: Method of Steepest Ascent, Second-Order Response Surface, Experimental Designs, Computer Models, Mixture Experiments, Evolutionary Operations, Advanced Design of Experiments: Random Effects Models, Analysis of Covariance, Non-Normal Response, and Taguchi Methods.

Recommended Books:

1. Design and Analysis of Experiments, D. C. Montgomery, John Wiley & Sons, Wiley Student Edition, International Student Version, 7th Edition.
2. Experimental Design: From User Studies to Psychophysics, D. W. Cunningham and C. Wallraven, CRC Press.
3. Design of Experiments: An Introduction Based on Linear Models, M. Morris, Chapman & Hall/CRC Texts in Statistical Science, First Edition.
4. Experiments: Planning, Analysis, and Optimization C. F. J. Wu and M. S. Hamada, Wiley Series in Probability and Statistics, Wiley.
5. Statistics for Experimenters: Design, Innovation, and Discovery, G. E. P. Box, J. S. Hunter, and W. G. Hunter, Wiley, 2nd Edition.
6. Practical Guide to Designed Experiments: A Unified Approach, P. D. Funkenbusch, CRC Press.

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MC 1	BH6401	Mathematical Methods in Engineering	3	0	0	3

Refer Appendix-I for detailed Syllabus.

MC 2	MS6403	Research Methodology and IPR	2	0	0	2

Refer Appendix-I for detailed Syllabus.

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LC 1	MS6541	Mechanical Systems Simulation Lab	0	0	4	2

1. To develop learn and apply new theories, concepts, and methods.
2. To develop extensive knowledge and understanding of a wide range of computer modelling and simulation software.
3. Identify, formulates, and solves engineering problems.
4. Apply knowledge of mathematics, science, and engineering.
5. Design and conduct experiments, as well as to analyze and interpret data.
6. Handsome command over ADAMS/View and ADAMS/Solver
7. Firm grasp of multi-body dynamics fundamentals.

List of Experiments:

1. **Introduction to ADAMS Software**
2. **Four Bar Mechanisms**
3. **Quick Return Mechanism**
4. **Gear Trains**
5. **Cam-Follower**
6. **Spring**

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LC 2	MS6543	Experimental Techniques for Mechanical Engineers	0	0	4	2

List of Experiments:

- Dimension Measurement
- Weight & Forces Measurement
- Torque Measurement
- Torque Measurement
- Temperature Measurement
- Data Acquisition and Analysis

AC 1	Any One from the List of AC 1 (Appendix-I)	2	0	0	0

Refer Appendix-I for detailed Syllabus.

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2nd Semester

PC 3	MS6142	Advanced Mechanical Vibration	3	0	0	3

Module-I

Review of vibration fundamentals for SDOF system, 2-DOF System and MDOF Systems: SDOF Systems: Equilibrium method, Energy method, Raylegh's method, Laws of damping, Free Vibration, Logarithmic decrement, Forced Vibration with Harmonic Excitation, Base Excitation and Rotating Unbalance, Frequency Response, Transmissibility and Vibration Isolation, Vibration Measuring Instruments, Forced Vibration with non-harmonic and transient excitation: Fourier analysis, Response to arbitrary loading (Duhamel and Convolution Integral), Impulse response. 2-DOF and MDOF Systems: Generalized Derivation of Equation of motion, Normal mode vibration, coordinate coupling, Langrange's equations, influence coefficients, modal analysis, orthogonality of normal modes, Free and Forced Vibration.

Module-II

Vibration of Continuous Systems:

Generalized Co-ordinates, Principle of dynamics: D'Alembert's principle, Hamilton's principle; Transverse Vibrations of Strings, Axial and Torsional Vibrations of Bars, Variational Formulation, Modal Analysis, Properties of Eigenvalue Problem, Modal Analysis, Energy Methods: Rayleigh's method, Rayleigh- Ritz method, Initial Value Problem, Forced Vibration Analysis.

Axially Translating Strings, D'Alembert's Solution, Harmonic Waves and Energetics of Wave Motion, Scattering of Waves, Applications of Wave Solution; Beam Models: Euler Bernouli Beam and Timoshenko Beam, Modal Analysis of Beams, Application of Modal Solution, Approximate Methods: Matrix Iteration Method, Stodola Method, Holzer method, Myklestad Thomson method, Transfer matrix method.

Module-III

Topics in Beam Vibrations, Wave Propagation in Beams, Vibration of Rotating Beams, Dynamics of Membranes, Vibrations of Rectangular Membrane, Vibrations of Circular Membrane, Dynamics of Plates, Vibrations of Rectangular Plates, Vibrations of Circular Plates.

Text Books:

1. Theory of Vibration with Applications, W. T. Thomson, CBS Publ., 1990
2. Vibrations and Waves in Continuous Mechanical Systems, Peter Hagedorn and AnirbanDasGupta, Wiley, 2007
3. Dynamic of structures, Walter C. Hurty and Moshe F. Rubinstein, PHI

Reference Books:

1. Elements of Vibration Analysis, L. Meirovitch, TMH, Second edition, 2007.
1. Analytical Methods in Vibrations, Leonard Meirovitch, The Macmillan Co., 1967
2. Mechanical Vibrations: Analysis, Uncertainties, and Control, HaymBenaroya, Prentice Hall
3. Dynamic of structures, Ray W. Clough and Joseph Penzien, International Student Edition.
4. Advanced Theory of Vibration – J. S. Rao, New Age Publication
5. Vibration of Continuous Systems, S. S. Rao, Wiley, 2007
6. Linear and Non-linear Structural Mechanics, A. H. Nayfeh and P. F. Pai,2004

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PC 4	MS6144	Dynamics and Control of Mechanical Systems	3	0	0	3

Module-I

Revisit to the history of development of mechanics from Galileo to Newton. Kinematics of rigid bodies - coordinate transformation, angular velocity vector, description of velocity and acceleration in relatively moving frames. Euler angles, Review of methods of momentum and angular momentum of system of particles, inertia tensor of rigid body.

Module-II

Dynamics of rigid bodies - Euler's equation, application to motion of symmetric tops and gyroscopes and problems of system of bodies. Kinetic energy of a rigid body, virtual displacement and classification of constraints. D' Alembert's principle. Introduction to generalized coordinates, derivation of Lagrange's equation from D' Alembert's principle. Small oscillations, matrix formulation, Eigen value problem and numerical solutions. Introduction to MAPLE® and MATLAB®, computer generation and solution of equations of motion.

Module-III

Introduction to complex analytic functions, Laplace and Fourier transform. Transfer function and block diagrams, Time and frequency domain system behavior. Root-locus, Bode and Nyquist plots; stability and sensitivity; PID controllers, Phase lag and Phase lead compensation. Analysis of Control systems in state space, pole placement, computer simulation through MATLAB - SIMULINK®.

Text Books:

1 Methods of Analytical Dynamics - Leonard Meirovitch – Dover.
2 Modern Control Engineering - Katsuhiko Ogata - Prentice Hall.

Reference Books:

1 A Mathematical Introduction to Control Theory - ShlomoEngelberg - World Scientific Publishing Company.
2 Computational Methods in Multibody Dynamics -Farid M. L. Amirouche - Prentice Hall.
3 MATLAB® for Control Engineers - Katsuhiko Ogata - Prentice Hall.
4 Dynamical Systems with Applications using Maple® - Stephen Lynch - Birkhäuser Boston.
5 Classical Dynamics - Donald T. Greenwood – Dover.
6 Advanced Dynamics - Donald T. Greenwood – Cambridge University Press.
7 Analytical Mechanics - Herbert Goldstein - Addison Wesley.
8 Engineering Mechanics: Dynamics – I. H. Shames, Prentice-Hall of India.
9 Dynamics: Theory and Applications - T.R. Kane, David A. Levinson - McGraw-Hill.

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Syllabus (Effective from 2023-24)

School/ Department: School of Mechanical Sciences
Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

PE 2	MS6242	Computational Techniques for Mechanical Systems	3	0	0	3

Module-I:
Neural Networks: Artificial Neural Network and Introduction, Learning Rules, Knowledge Representation and Acquisition, Different Methods of Learning. Algorithms of Neural Network: Feed-forward Error Back Propagation, Hopfield Model, Kohonen's Featrure Map, K-Means Clustering, ART Networks, RBFN, Application of Neural Network to the relevant field.

Module-II:
Fuzzy Logic: Basic Concepts of Fuzzy Logic, Fuzzy vs Crisp Set, Linguistic variables, Membership Functions, Operations of Fuzzy Sets, Fuzzy If-Then Rules, Variable Inference Techniques, Defuzzification, Basic Fuzzy Inference Algorithm, Fuzzy System Design, FKBC and PID Control, Antilock Braking System(ABS), Industrial Applications.

Module-III:
NON-LINEAR Programming: Newton's Method, Augmented Langrange Multiplier Method, Dynamic Programming Genetic Algorithm: GA and Genetic Engineering, Finite Element based Optimization, Hybridization of Optimization Technique, Application of Optimization Technique for Solving Projects (Project solutions)

Books:

1. Neural Networks- by Simon Haykin
2. Fuzzy Logic with Engineering Application- by ROSS J.T (Tata Mc)
3. Neural Networks and Fuzzy Logic – by Bart Kosko
4. Ashok D. Begundu&chandrapatla T.R "Optimization concept and application in engineering",Prentice Hall,1999
5. Rao S.S "Engineering Optimization"
6. Gill, Murray and Wright," Practical Optimization"
7. Optimization Research;PrabhakarPai,Oxford University Press.

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Syllabus (Effective from 2023-24)

School/ Department: School of Mechanical Sciences
Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

PE 2	MS6244	Acoustics and Noise Control	3	0	0	3

Module-I

Sound: Concepts of source, pathway and receiver; Sound power and sound power level; Sound intensity and sound intensity level; Sound pressure, RMS and peak values, and sound pressure level; Addition and averaging of the levels; Relationship between sound pressure and sound intensity at a location in a free field; Equations to predict the sound pressure level (and sound intensity level) due to point, line and plane sources under free field conditions. Façade effect; Source directivity, directivity index, directivity factor. Indices of time-varying sound; Physical principles of the propagation of a travelling compression wave: frequency, wavelength, speed (including effects of temperature); Equation for a one-dimensional travelling pressure wave as a function of time and position; Reflection and the laws of reflection, reflection coefficient; absorption and absorption coefficient. Porous, panel and resonant absorbers; Refraction, including meteorological effects; Diffraction, including infinite-length barriers; Absorption during propagation through the medium; Coherent and incoherent sources; Principle of superposition of waves, interference, beats, standing waves (and standing wave ratio). Principle of active noise control. Doppler effect.

Module-II

Sound propagation within and between spaces

Reverberation time, its measurement, prediction and control. Sabine equation; Diffuse sound fields, energy density, room constant, reverberant sound pressure level and its measurement, prediction and control. Sound intensity at the boundary of a diffuse field. Total sound pressure level in an enclosed space due to a directional source. Room radius; Sound transmission through single-leaf, homogeneous partitions; transmission coefficient, sound reduction index, mass law, coincidence effect. Composite (but single-leaf) partitions, effects of holes and gaps and flanking. Level difference, Standardized level difference; Sound transmission between enclosed spaces; Sound transmission between an enclosed space and free field conditions; and vice versa; Impact noise: impact sound pressure level; standardized impact sound pressure level.

Human response to sound and vibration; and psychoacoustics:

Human auditory system; Range of audible sound pressure levels and frequencies, infra sound, ultra sound. Pitch; Loudness: equal loudness contours and loudness level. Loudness calculations. Masking; Frequency weightings; Hearing disorders: effects of age, health and noise exposure on hearing acuity; Individual noise susceptibility; Audiometry; basic procedures of manual and automatic audiometry; audiograms; Assessment of noise dose, hearing protectors and their use; Regulatory issues; Effects of noise and vibration on humans and human activity; Indices and methods of assessment of noise and vibration exposures.

Module-III

Measurement of sound and vibration:

Measurement microphones: construction and mode of operation, sensitivity, linearity, frequency response, polar response, dynamic range; Relevant standards for sound level meters; Calibration and calibrators. The role of reference microphones; Primary and secondary standards; traceability of standards; Uncertainties in measured values, tolerance; Sound level meter features, including: frequency weightings; fast, slow, impulse and peak time weighting; octave and one-third-octave band filters; windshields; Measurement of sound pressure level (including indices for time-varying sounds and in diffuse and free fields), sound power level, sound intensity level, reverberation time. Measurement of impact noise. Using frequency weighting networks and octave and one-third-octave band filters where appropriate; Introduction to Fourier techniques; Principles of vibration measurement: displacement, velocity and acceleration; Vibration transducers and the principles of associated instrumentation.

Text Books:

1. Fundamentals of Acoustics by L. E. Kinsler, A. R. Frey, A. B. Coppens and J. V. Sanders, John Wiley & Sons (2000). 2. Acoustics and Noise Control,
2. B. J. Smith, R. J. Peters, Stephanie Owen, Addison-Wesley Longman Ltd (1982)

Reference Books:

1. Foundations of Engineering Acoustics by F. H. Fahy, Academic Press (2001).
2. Acoustics of ducts & Mufflers by M. L. Munjal, Wiley (2014)
3. Engineering Acoustics: An Introduction to Noise Control, Michael Möser, Stefan Zimmermann, Rebecca Ellis, Springer (2009)

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Syllabus (Effective from 2023-24)

School/ Department: School of Mechanical Sciences
Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

PE 2	MS6246	Applied Ergonomics	3	0	0	3

Module-I
Introduction
Introduction to the concept of system design in product design, Analysis of MMEystem design, How to assess the interface design, Design methodology, Body dimensions and its application in design, Dimensional optimization for the population and use of percentile,

Module-II
The musculo-skeletal system and joint motion study, Human body follows the principle of lever, Basic model on calculation of biomechanical stresses on our body. Effect of stresses imposed on body. Design from the view point of biomechanics, Work posture analysis, Static and Dynamic work, The visual, auditory and thermal environment and their impact on design. Design for the physically challenged.

Module-III
Controls and display Psycho physiological aspects of design. Research techniques in Ergonomic data generation, interpretation and application of statistical methods. Case analysis. Mini Project work involving Ergonomic design research for product system.

Reference Books:

1. R. S. Bridger, "Introduction to Ergonomics", CRC Press.
2. Work Systems and the Methods, Measurement, and Management of Work, by Mikell P. Groover, ISBN 0-13-140650-7. ©2007 Pearson Education, Inc., Upper Saddle River, NJ. All rights reserved.
3. An Introduction to Human Factors Engineering by Christopher D. Wickens
4. The practice and management of Industrial Ergonomics by David C. A.
5. Engineering Psychology and Cognitive Ergonomics (Ed. Don Harris) Nonlinear Oscillations in Physical Systems, C. Hayashi, McGraw-Hill, 1964.

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Syllabus (Effective from 2023-24)

School/ Department: School of Mechanical Sciences
Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

PE 2	MS6248	Rotor Dynamics	3	0	0	3

Module-I

Rudiments of Rotor Dynamics, Rotor Dynamic considerations in machinery design, critical speeds and unbalance response. Factors affecting them such as gyroscopic action, internal damping, fluid film bearings. Methods for analysis such as Transfer Matrix, FEM etc.

Module-II

Vibration of Discs, disc gyroscopics, synchronous and non-synchronous whirl, analysis of rotors mounted on hydrodynamic bearings, application to two spool and multispool rotors. Analysis of asymmetric shafts. Parametric excitation and instability due to fluid film forces and hysteresis. Effect of support nonlinearities.

Module-III

Rigid rotor balancing. Torsional vibration. Balancing of rotors. Concepts of condition monitoring.

Text Books:

1. Rotor Dynamics – J. S. Rao. New Age International Publications, 3rd Edition.

Reference Books:

1. Dynamics of Rotor Bearings Systems – M. J. Goodwin. Unwin Hyman
2. A Matrix Method in Elastomechanics – E. C. Petal and F. A. Leckie. Mc Graw Hill.
3. Rotor Dynamics – E. K. Kramer. Springer Verlag.
4. Rotor Dynamics – H. D. Nelson and E. J. Guntur. Mc Graw Hill Book Co.
5. Rotor Dynamics – J. S. Vance. Mc Graw Hill Book Co.
6. Some Problems of Rotordynamics – A. Tondol. House of Czechoslovakia Academy of Science, Prague.

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Syllabus (Effective from 2023-24)

School/ Department: School of Mechanical Sciences
Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

PE 3	MS6250	Composite Materials	3	0	0	3

Module I

Review on definition, classification & fabrication technologies of composites. Principles of composites, micromechanics of composites. Various types of reinforcements and their properties. Role of interfaces.

Module II

Fabrication of metal matrix composites: Insitu, dispersion hardened, particle, whisker and fibre reinforced; composite coatings by electro deposition and spray forming; Fabrication of polymeric and ceramic matrix composites.

Module III

Mechanical physical properties of composites. Mechanisms of fracture in composites. Property evaluation and NDT of composites. Wear and environmental effects in composites.

Text Books:

1. Mechanics of composite materials, R. M. Jones, Mc Graw Hill Book Co.
2. Mechanics of composite materials & structures, M Mukhopadhay, Universities Press.
3. Fiber-Reinforced composite materials, Manufacturing & Design, P. K. Mallick, Marcel Dekken, Inc. New York & Basel.

Reference Books:

1. Composites, Engineered Materials Handbook, Vol.1, ASM International, Ohio, 1988.
2. F.L. Matthews and R.D. Rawlings, Composite Materials: Engineering and Science, Chapman & Hall, London, 1994.
3. Weinheim, Structure and Properties of Composites, Materials Science &Technology, Vol. 13, VCH, Germany, 1993.
4. J.Prasad /CGK Nair, NDT and Evaluation of Materials, Mc Graw Hill

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Syllabus (Effective from 2023-24)

School/ Department: School of Mechanical Sciences
Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

PE 3	MS6252	Engineering Design Optimization	3	0	0	3

Module I

Optimization problem formulation - Design variables, constraints, objective function and variable; bounds. Single-Variable.; Single Variable Optimization Algorithm: Bracketing

Module II

Melliotls Exhaustive Search Method and bounding; Phase Method.; Region Elimination Methods: Fibonacci Search method and Golden section search method. Gradient based methods, Newton - Raphson method, Bisection Method, Secant Method, and Cubic Search Method. Computer programs for bounding phase method and golden section search method.; Multivariable Optimization Algorithms: Direct search methods. Simplex search method and Hooke- Jeeves pattern search method. Gradient based methods, Cauchy's (steepest descent) method and Newton’s method.

Module III

Constrained Optimization Algorithms- Kuhn- Tucker conditions, penalty function. Method, method of multipliers, cutting plane method, Generalized Reduced Gradient method, computer program for penalty function method. Integer programming - penalty function method. Global optimization using the steepest descent method, genetic algorithms and simulated annealing.

Text Book:

1. K.Deb, Optimization in Engineering Design, PHI.

Reference Book:

1. S. S. Rao, Optimization methods, PHI.

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Syllabus (Effective from 2023-24)

School/ Department: School of Mechanical Sciences
Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

PE 3	MS6254	Engineering Measurements	3	0	0	3

Module I

Principles of Measurement: Static characteristics and accuracy in the steady state, Generalized model, Measurement errors and error reduction techniques, Dynamic characteristics, Loading effects and noise, Transfer function, TiMEnd frequency responses,

Module II

Dynamic errors and compensation, Random signals and effects of noise and interference, Noise sources and reduction methods, Economics of measurement systems: Reliability, Selection of measurement systems, Operating cost; Measurement System Design: Sensing elements: resistive, capacitive, inductive, electromagnetic and other sensing elements, Signal conditioning and processing elements: deflection bridges, amplifiers, AC carrier systems, current transmitters, oscillators and resonators, A/D conversion, sampling, quantization and encoding,

Module III

Data Acquisition, Multiplexing, Data acquisition system, digital signal analysis; Specialized Measurement Systems: Principles of flow, optical and ultrasonic measurement systems, Heat transfer effects and particle size analysis.

Recommended Books:

1. Theory and Design for Mechanical Measurements - Richard S. Figliola, Donald E. Beasley (John Wiley & Sons)
2. Mechanical Measurements - Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard, V (Pearson)
3. Instrumentation: Measurement and Analysis - B.C. Nakraand K.K. Chaudhry (Tata Mcgraw-hill Education Private Ltd.)

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Syllabus (Effective from 2023-24)

School/ Department: School of Mechanical Sciences
Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

PE 3	MS6256	Robotics and Automation	3	0	0	3

Module-I

Robotics: Historical back ground, Definitions. Laws of Robotics, Robotics systematic robot anatomy; Common Robot configurations, coordinate system, work envelop. Elements of robotic system and effector, actuators, controller, teach pendant, sensors Specification of robots.

Module-II

Homogeneous transformations, D-H parameter notation, direct & inverse kinematics of manipulators: examples of kinematics of some common manipulator configurations. Jacobian, dynamics of manipulators: L-E formulation, N-E formulation, trajectory planning. Automation, types of automation, analysis of automated assembly systems, line balancing problems, analysis of automated material handling systems, automated storage and retrieval systems

Module-III

Sensors: Need for sensing systems, Sensory devices, Types of sensors, Robot vision system Robot Languages and Programming: Types of Programming, Motions Programming, Robot Languages - VAL systems.; Flexible automation: Technology, FMS, Function of Robot in FMS flexible manufacturing cell.

Text Book:

1. S.R Deb, *Robotic technology and flexible automation* - TMH.
2. Robotics and Control / Mittal R K &Nagrath I J / TMH.

Reference Books:

1. Lee, Fu, Gonzalez, *Robotics* - Mc Graw Hill.
2. Groover, *Industrial Robot* - Mc Graw Hill.
3. Paul Afonh, *Robots manufacturing and application* - John Wiley.

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Syllabus (Effective from 2023-24)

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Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

OE 1	Any One from the List of OE 1 (Appendix-I)	3	0	0	3

Refer Appendix-I for detailed Syllabus.

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Syllabus (Effective from 2023-24)

School/ Department: School of Mechanical Sciences
Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

PR 1	MS6642	Project (Specialization Related)	0	0	4	2

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Syllabus (Effective from 2023-24)

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Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

LC 3	MS6542	Computational Techniques for Mechanical Systems Lab	0	0	4	2

List of Experiments:

1. To perform Union, Intersection and Complement operations.
2. To implement De-Morgan's Law.
3. To plot various membership functions.
4. To implement FIS Editor. Use Fuzzy toolbox to model tip value that is given after a dinner based on quality and service.
5. To implement FIS Editor.
6. Generate ANDNOT function using McCulloch-Pitts neural net.
7. Generate XOR function using McCulloch-Pitts neural net. 8. Hebb Net to classify two dimensional input patterns in bipolar with given targets.
9. Perceptron net for an AND function with bipolar inputs and targets.
10. To calculate the weights for given patterns using hetero associative neural net.
11. To store vector in an auto-associative net. Find weight matrix & test the net with input
12. To store the vector, find the weight matrix with no self-connection.
    Test this using a discrete Hopfield net.

AC 2	Any One from the List of AC 2 (Appendix-I)	2	0	0	0

Refer Appendix-I for detailed Syllabus.

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Syllabus (Effective from 2023-24)

School/ Department: School of Mechanical Sciences
Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

3rd Semester

PE 4	MS7241	Robot Mechanics and Control	3	0	0	3

Course Objectives:

After completion of the course, a student should be able to:

CO1 Select appropriate sensors and actuators for a particular robot task.

CO2 Evaluate inverse and forward kinematics of robot manipulators.

CO3 Derive the equations of motion for robot manipulators and perform dynamic analyses.

CO4 Write basic programs for controlling robot manipulators using embedded systems.

Module-I

Robot Classification, Serial and Parallel Manipulators, Robot Selection and Application, Sensors and Actuators, Motion and Force Sensing, Actuation Schemes, Electric, Hydraulic, and Pneumatic.

Module-II

Robot Kinematics, Degrees of freedom and mobility, Rotation representation, Coordinate transformations, DH parameters, Matrix methods for forward and inverse kinematics analyses, Jacobian and Singularity.

Module-III

Robot Dynamics and Control, Euler-Lagrange and Newton-Euler equations of motion for robot manipulators, Inverse and forward dynamic analyses, linear control of robot manipulators, microcontroller programming.

Text Book:

1. Craig, J. J., Introduction to Robotics: Mechanics and Control, Pearson, 3rd Edition, 2004.

Other References and Texts:

1. Siciliano, Bruno, Khatib, Oussama, Springer Handbook of Robotics, Springer, 2016.
2. Alciatore David G & Histand Michael B, Introduction to Mechatronics and Measurement Systems, 4th Edition, Tata McGraw Hill, 2006.
3. Saha, Subir Kumar. Introduction to Robotics. Tata McGraw-Hill Education, 2014.
4. Ghosal, Ashitava. Robotics: Fundamental Concepts and Analysis, Oxford, 2006.
5. Spong, Mark W., Seth Hutchinson, and Mathukumalli Vidyasagar. Robot Modelling and Control. Vol. 3. New York: Wiley, 2006.

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Syllabus (Effective from 2023-24)

School/ Department: School of Mechanical Sciences
Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

PE 4	MS7243	Sensors and Actuators in Industry	3	0	0	3

Course Objectives:

1. To understand basics of sensors, actuators and their operating principle.
2. To study the various sensors and actuators, applications of MEMS to disciplines beyond Electrical and Mechanical.

Course Outcomes:

Upon completion of the course, the students will be able to:

CO1: Use concepts in common methods for converting a physical parameter into an electrical quantity.

CO2: Design and develop sensors using optical methods with desired properties.

CO3: Analyse the applications of Strain gauges, strain gauge, beam force sensor, piezoelectric force sensor, load cell, torque sensor in industries

CO4: Evaluate performance characteristics of different types of actuator.

Syllabus:

Module I:

Sensor fundamentals and characteristics, Sensor Classification: Position, Direction, Displacement and Level sensors, Performance and Types, Error Analysis characteristics.

Optical Sources and Detectors: Electronic and Optical properties of semiconductor as sensors, LED, Semiconductor lasers, Fiber optic sensors, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs. Brief overview of measurement systems, classification, characteristics and calibration of different sensors.

Module II:

Strain gauges, strain gage beam force sensor, piezoelectric force sensor, load cell, torque sensor, Piezo-resistive and capacitive pressure sensor, optoelectronic pressure sensors, vacuum sensors.

Hydraulic and Pneumatic Actuators: Actuators, definition, example, types, selection. Pneumatic actuator, Electro Pneumatic actuator. Hydraulic actuator, control valves, valve sizing valve selection

Module III:

Electrical actuating systems: solid-state switches, solenoids, voice coil; electric motors; DC motors, AC motors, single phase motor; 3-phase motor; induction motor; synchronous motor; stepper motors.

Piezoelectric actuator: characterization, operation, and fabrication; shape memory alloys, Linear actuators

Text Books:

1. Gregory Kovacs, “Micro machined Transducers Sourcebook”, McGraw-Hill, New York (1998).

Reference Books:

1. John G. Webster, Editor-in-chief, “Measurement, Instrumentation, and Sensors Handbook”, CRC Press (1999).

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Syllabus (Effective from 2023-24)

School/ Department: School of Mechanical Sciences
Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

PE 4	MS7245	Artificial Intelligence	3	0	0	3

Course Objectives:

1. To educate the student to understand the concept of AI and its real applications in digital world.
2. To study the various types of logic Programming and Learning Paradigms in AI

Course Outcomes:

Students will be able to:

CO1: Understand the concept of AI and solve the problems of different Heuristic search techniques
CO2: Apply the concept of logic programming and Fuzzy logic in AI
CO3: Acquire the knowledge of Artificial Neural Network and Convolutional Neural Network
CO4: Demonstrate proficiency developing applications in 'AI language', expert system shell and data mining tools.

Syllabus:

Module I:

Introduction: What is AI, History, AI problems, Production Systems, Problem characteristics, Intelligent Agents, Agent Architecture, AI Application (E-Commerce, & Medicine), AI Representation, Properties of internal representation, Future scope of AI , Issues in design of search algorithms.

Heuristic search techniques: Heuristic search, Hill Climbing, Best first search, mean and end analysis, Constraint Satisfaction, A* and AO* Algorithm, Knowledge Representation: Basic concepts, Knowledge representation Paradigms, Propositional Logic, Inference Rules in Propositional Logic, Knowledge representation using Predicate logic, Predicate Calculus, Predicate and arguments, ISA hierarchy, Frame notation, Resolution, Natural Deduction

Module II:

Logic Programming: Introduction, Logic, Logic Programming, Forward and Backward reasoning, forward and Backward chaining rules. Knowledge representation using non monotonic logic: TMS (Truth maintenance system), statistical and probabilistic reasoning, structure knowledge representation, semantic net, Frames, Script, Conceptual dependency

Fuzzy Logic: Crisp sets, fuzzy sets, fuzzy set operations, properties, membership function, Fuzziness, fuzzification and defuzzification methods, fuzzy relations, operation on fuzzy relations, fuzzy numbers and arithmetic, fuzzy implications, approximate reasoning, systems based on fuzzy rules, fuzzy inference, Neuro fuzzy systems, adaptive neuro-fuzzy inference system, evolutionary neural networks, fuzzy evolutionary systems, Neuro Genetic, Genetic-Fuzzy systems Application of fuzzy-logic to engineering problems, Fuzzy control systems, Fault diagnosis

Artificial Neural Network: Introduction, Biological foundation, Mathematical model of biological neuron, Types of activation function, Feed-forward and Feedback ANN model

Module III:

Learning Paradigms: Supervised and unsupervised learning, learning rules, single layer and multilayer perceptron model, error back propagation learning algorithm, pattern classification, clustering, Introduction to generative AI and CNN, radial basis function network, support vector machines, Hopfield network, Associative memory and CNN, applications of ANN models to engineering problems

Evolutionary Techniques: Introduction and concepts of genetic algorithms and evolutionary programming

Textbooks:

1. Nils J. Nilsson, “Artificial Intelligence: A new Synthesis”, Harcourt Asia Pvt. Ltd., 2000.
2. Elaine Rich and Kevin Knight, “Artificial Intelligence”, 2nd Edition, Tata McGraw-Hill, 2003. 3. George
3. F. Luger, “Artificial Intelligence-Structures and Strategies for Complex Problem Solving”, Pearson Education / PHI, 2002.

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Syllabus (Effective from 2023-24)

School/ Department: School of Mechanical Sciences
Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

PE 4	MS7247	Fundamentals of Mechatronics	3	0	0	3

Course Objectives:

1. To educate the student to understand the fundamentals of Mechatronics.
2. To study the design of hydraulic circuits

Course Outcomes:

Students will be able to:

CO1: Understand the concept of Mechatronics and its characteristics and components in mechatronics systems.
CO2: Apply the concept of Drives and Indexing mechanism in Mechatronic system
CO3: Understand the role of Signal Conditioning, Op-Amp and Microprocessor in Mechatronics
CO4: Discuss the concept of Hydraulic systems and Pneumatics and evaluate part programming in Mechatronics system

Syllabus:

Module I:

Introduction: Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach.

Drives: stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by Camshafts, electronic cams, indexing Mechanisms, tool magazines and transfer systems.

Module II:

Introduction to Signal Conditioning & Op-Amp, OP-AMP As Signal Conditioner, Analogue To Digital Converters, Digital To Analogue Converters, Microprocessor, Microcontroller, Artificial Intelligence.

Module 3:

Hydraulic systems: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, and pumps. Design of hydraulic circuits. Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, Design of systems, Description of PID controllers, CNC machines and part programming

Text Books:

1. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988.
2. G.W. Kurtz, J.K. Schueller, P.W. Claar. II, Machine design for mobile and industrial applications, SAE, 1994.

Reference Books:

1. T.O. Boucher, Computer automation in manufacturing - an Introduction, Chappman and Hall, 1996.

PR 2	MS7641	Dissertation (Phase-I)	0	0	24	12

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Syllabus (Effective from 2023-24)

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Course: M. Tech., Programme: Mechanical System Design (MSD),
Duration: 2 years (Four Semesters)

4th Semester

PR 3	MS7642	Dissertation (Phase-II)	0	0	32	16