INDIAN INSTITUTE OF INFORMATION TECHNOLOGY BHAGALPUR

Mechatronics Engineering (MEA)

B.Tech. Curricula and Syllabus

Semester -VI

Course Code	Course Name	L	T	P	C	Year	Semester	Semester Total credit
ME303	Mechatronics and Automation	3	0	0	3	3	6	21
ME32X	Elective-I	3	1	0	4			
ME33X	Elective-II	3	0	0	3			
ME306	Environmental Science and Green Technology	2	0	0	2			
CS307	Machine Learning	3	0	0	3			
ME311	Mechatronics LAB	0	0	3	2			
ME312	Sensors and Control LAB	0	0	3	2			
CS314	Machine Learning LAB	0	0	3	2			
Society Academia Industry Internship Seminar								

Elective I

Semester	Area	Subject
VI	Mechatronics(Mechanical)	Industrial Engineering, CAD/CAM
VI	Computation	Computational Intelligence, FEM
VI	Mechatronics (Electrical)	Electric Hybrid vehicle/ Advance Electrical Machine Design

Elective-II

Semester	Area	Subject
VI	Mechatronics(Mechanical)	Micro-manufacturing, Introduction to Composite Materials
VI	Computation	Scientific Computation, Optimization methods in Engineering
VI	Mechatronics (Electrical)	MEMS and NEMS, Power Electronics

Syllabus:

Course Code	Course name	L	T	P	C	Year	Semester
ME303	Mechatronics and Automation	3	0	0	3	3rd	6th
Course objective: To introduce the need, evolution, and motivation for Industrial Automation. Familiarization with basic concepts and different automation strategies being used in practice worldwide.							

Contents	**No. of Lectures**
Module : 1	
Introduction to design of mechatronics system: What is mechatronics – the design process, Systems, Measurement systems, Control systems, Programmable logic controller, Example of mechatronic systems.	**7**
Module : 2	
Basic system modelling: Mathematical models, Mechanical system building blocks, Electrical system building blocks, Fluid system building blocks, Thermal system building blocks	**8**
Module : 3	
Mechatronic system modelling: Engineering systems: Rotational – translational, electro-mechanical, pneumatic-mechanical, hydraulic-mechanical, micro electro mechanical system – Dynamic responses of system: first order, second order system – Performance measures.	**8**
Module : 4	
Programmable logic controller: Introduction — Principles of operation – PLC Architecture and specifications – PLC hardware components Analog & digital I/O modules, CPU & memory module – Programming devices – PLC ladder diagram, Converting simple relay ladder diagram into ladder diagram. PLC programming- Simple instructions – Manually operated switches – Mechanically operated switches - Latching relays.	**8**
Module : 5	
Applications of PLC: Timer instructions - On delay, Off delay, Cyclic and Retentive timers, Up /Down Counters, control instructions – Data manipulating instructions, math instructions; Applications of PLC – Motor start and stop, Simple materials handling applications, Automatic water level controller, Automatic lubrication of supplier	**10**

Conveyor belt, Automatic car washing machine, Bottle label detection and process control application.	
Total	**42**

Text	1. Gary Dunning, "Introduction to Programmable Logic Controllers",3rd India edition, Cengage Learning, 2007 2. John Webb, "Programmable Logic Controllers: Principles and Applications",5th edition Prentice Hall of India, 2012.
Reference	1. W. Bolton, "Mechatronics: electronic control systems in mechanical and electrical engineering", Longman, Singapore, 1999

Course Code	Course name	L	T	P	C	Year	Semester
ME306	Environmental Sciences & Green Technology	2	0	0	2	3rd	6th

Course objective: To bring in the importance and the underlying principles of green and sustainable technology.

Topic	Contents	No. of Lectures
Module-1	Introduction to Environmental Pollution: Environmental Awareness, Concept of an ecosystem, structure and function of an ecosystem, energy and nutrient flow, biogeochemical cycles, sources, pathways and fate of environmental pollutants.	**05**
Module-2	Air pollution- Introduction, Segments of environment, Layers of atmosphere and their significance; Mechanism, Causative factors, Consequences and Preventive measures – Ozone depletion, Greenhouse effect and Global warming; Earth's radiation budget, Classification of air pollutants, Indoor air pollution, Smog-photochemical and sulphurous, Acid rain, Air Quality Standards, Human health effects-Bhopal gas tragedy.	**05**
Module-3	Water Resource; Water Pollution : Definition, Classification , Sources of Contamination, Pollutants & their Detrimental Effects; Water Quality: Portability limit – WHO and PHED Specification; Water Quality Monitoring, Municipal Water Treatment: Slow and Rapid Sand Filter, Disinfection – Methods, Advantages & Disadvantages, Sterilization	**05**
Module-4	Soil and Noise pollution: Lithosphere and Soil profile, Soil contamination, sources of soil contamination, Important environmental properties of soil contaminants, Ecological & Health effects, Exposure & Risk Assessment; Noise pollution: Brief introduction to noise pollution, source, measurement and prevention of noise pollution	**05**
Module-5	Radioactive Pollution & Solid Waste Management: Radioactive pollutant: units of radiation and instruments for their measurements, types of radioactive pollutants and risk factor associated with these radiations Radioactive waste and their disposal, accidental leakage of	**05**

	radiation from nuclear reactors (discuss Chernobyl and Fukushima) Solid waste management different types of solid waste, composting, biological methods of detoxification of hazardous waste Onsite handling and composting, integrated solid waste management,	
	Total	**42**
Text	1. Miller, T. G. Jr., *Environmental Science*, Wadsworth Publishing House, USA. 2. Masters, G.M, *Introduction to Environmental Engineering.*	

Course Code	**Course Name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
CS307	Machine Learning	3	0	0	3	3rd	6th
Course Objective: Machine learning is the science of getting computers to act without being explicitly programmed. Machine learning is so pervasive today that you probably use it dozens of times a day without knowing it. This course will help the students to learn the necessary details to create next generation applications.							
	Contents						Hours
Module 1	Introduction: History of machine learning, Basic concepts						3
Module 2	Supervised learning: Supervised learning setup, LMS, Logistic regression, Perceptron, Exponential family, Generative learning algorithms, Gaussian discriminant analysis, Naive Bayes, Support vector machines, Model selection and feature selection, Ensemble methods: Bagging, boosting.						10
Module 3	Learning theory: Bias/variance trade-off, Union and Chernoff/Hoeffding bounds, VC dimension, Worst case (online) learning.						7
Module 4	Unsupervised learning: Clustering K-means, EM. Mixture of Gaussians, Factor analysis, PCA (Principal components analysis), ICA (Independent components analysis).						8
Module 5	Reinforcement learning and control: MDPs. Bellman equations, Value iteration and policy iteration, Linear quadratic regulation (LQR), Q-learning. Value function approximation, Policy search.						7
						Total	35
Text	1.Ethem Alpaydin, Introduction to Machine Learning, Second Edition, PHI, 2010. 2.Marsland, Stephen. Machine learning: an algorithmic perspective. Chapman and Hall/CRC, 2011.						
Reference	1. Murphy, Kevin P. "Machine Learning: A Probabilistic Perspective (Adaptive Computation and Machine Learning series)." (2018), MIT Press. 2. Brownlee, Jason. Machine Learning Mastery With Python: Understand Your Data, Create Accurate Models and Work Projects End-To-End. Jason Brownlee, 2016.						

Elective-I Course Syllabus

Course Code	**Course name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
ME32X	Industrial Engineering	3	1	0	4	3rd	6th
Course objective:							

1. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments.
2. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
3. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
4. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Topic	**Contents**	**No. of Lectures**
Module : 1		
Introduction, Production Planning and Control, Product design, Value analysis and value engineering, Plant location and layout, Equipment selection, Maintenance planning, Job, batch, and flowproduction methods,		**10**
Module : 2		
Group technology, Work study, Time and motion study, Incentive schemes, Work/job evaluation, Inventory control, Manufacturing planning: MRP, MRP-II, JIT, CIM,		**10**
Module : 3		
Quality control, Statistical process control, Acceptance sampling, Total quality management, Taguchi's Quality engineering. Forecasting, Scheduling and loading, Line balancing, Break-even analysis.		**10**
Module : 4		
Introduction to operations research, linear programming, Graphical method, Simplex method, Dual problem, dual simplex method, Concept of unit worth of resource, sensitivity analysis,		**10**
Module : 5		
Transportation problems, Assignment problems, Network models: CPM and PERT, Queuing theory		**8**
	Total	**48**
Text	1. S. L. Narasimhan, D. W. McLeavey, and P. J. Billington, Production, "Planning and Inventory Control", PrenticeHall, 1997. 2. J. L. Riggs, "Production Systems: Planning, Analysis and Control", 3rd Ed., Wiley, 1981	

Reference	1. Muhlemann, J. Oakland and K. Lockyer, "Productions and Operations Management", Macmillan, 1992. 2. H. A. Taha, "Operations Research -An Introduction", Prentice Hall of India, 1997.

Course Code	Course name	L	T	P	C	Year	Semester
ME32X	**CAD-CAM**	3	1	0	4	3rd	6th

Course objective:

1. To understand the concept of use of computer in product designing.
2. To understand about the various type of curves and their use in product developments.
3. To developed the programming skills for product development in machines.

Contents	No. of Lectures
Module 1	
Introduction and components of Computer aided design (CAD)/Computer aidedmanufacturing (CAM)/Computer aided engineering (CAE) systems, Basic concepts ofgraphics programming. **Transformations and Projections**: Definition, Rigid Body Transformations, deformations. Rendering; Graphical user interface, Computer aided drafting systems, Geometric modeling systems – wireframe, surface and solid modeling systems, Nonmanifold systems, Assembly and web-based modeling systems.	**8**
Module 2	
Differential Geometry of Curves: Curve Interpolation, Curve Fitting, Representing Curves, Differential Geometry of Curves. **Design of Curves:**Ferguson's or Hermite Cubic Segments, Three-Tangent Theorem, Barycentric Coordinates and Affine Transformation, Bézier Segments, Composite Bézier Curves, Rational Bézier Curves.	**8**
Module 3	
Splines: Definition, Why Splines?, Polynomial Splines, B-Splines (Basis-Splines), Newton's Divided Difference Method, Recursion Relation to Compute B-Spline Basis Functions, Properties of Normalized B-Spline Basis Functions, B-Spline Curves: Definition, Design Features with B-Spline Curves, Parameterization, Interpolation with B-Splines, Non-Uniform Rational B-Splines (NURBS).	**8**
Module 4	

Differential Geometry of Surfaces: Parametric Representation of Surfaces, Curves on a Surface, Deviation of the Surface from the Tangent Plane: Second Fundamental Matrix, Classification of Points on a Surface, Curvature of a Surface: Gaussian and Mean Curvature, Developable and Ruled Surfaces, Parallel Surfaces, Surfaces of Revolution, Sweep Surfaces, Curve of Intersection between Two Surfaces. Design of Surfaces: Tensor Product Surface Patch, Boundary Interpolation Surfaces, Composite Surfaces, B-Spline Surface Patch, Closed B-Spline Surface, Rational B-spline Patches (NURBS).	**8**
Module 5	
Introduction to optimization, CAD/CAM integration, Numerical control – Conceptsfor manual and computer assisted part programming, Virtual engineering – components and applications, Extensive laboratory work on CAD (Solid modeling software), CAM(manufacturing software), and CAE (Finite element analysis software).	**8**
Total	**40**

Text	1. Anupam Saxena and Birendra Sahay, "Computer Aided Engineering Design", Springer, 2005. 2. Kunwoo Lee, "Principles of CAD/CAM/CAE systems", Addison Wesley, 1999.
Reference	1. P. Radhakrishnan, S. Subramanyan, and V. Raju, "CAD/CAM/CIM" , 2nd edition, New Age, 2000.

Course Code	Course name	L	T	P	C	Year	Semester
ME32X	Computational Intelligence	3	1	0	4	3rd	6th

Course objective:

1. It provides an introduction to the basic principles, techniques, and applications of neural network theory and fuzzy logic theory
2. Introduce students to artificial neural networks and fuzzy theory from an engineering perspective

Contents	No. of Lectures
Module : 1	
Introduction to soft computing, hard computing, Need for soft computing; Neurons and neural networks;	**8**
Module : 2	
Basic models of artificial neural networks –single-layer perceptron, multilayer perceptron; Radial basis function networks; SOM; Recurrent neural networks;	**8**

Training of neural network; Applications of neural networks in mechanical engineering	
Module : 3	
Introduction to fuzzy sets, Fuzzy reasoning and clustering; Optimization tools –traditional and non-traditional, genetic algorithms, simulated annealing etc.;	**8**
Module : 4	
Genetic Algorithms–FuzzyLogic, Genetic Algorithms–Neural Networks, Neural Networks–Fuzzy Logic.	**8**
Total	**32**

Text	1. D. K. Pratihar, "Soft Computing", Narosa Publishing House, 2008. 2. S. Haykin, "Neural Networks: A Comprehensive Foundation", 2nd Ed, Pearson Education, 1999.
Reference	1. P. M. Dixit, U. S. Dixit, "Modeling of metal forming and machining processes: by finite element and soft computing methods", 1st Ed, Springer-Verlag, 2008. 2. K. Deb, "Optimization for Engineering Design: Algorithms and Examples", Prentice Hall, 2006.

Course Code	Course name	L	T	P	C	Year	Semester
ME32X	Finite Element Method	3	1	0	4	3rd	6th
Course objective: Finite Element Method (FEM) is a numerical technique for solving differential equations that describe many engineering problems. Main reason for its popularity is that the method results in computer codes which are versatile in nature that can solve many practical problems with minimum training. Obviously, there is danger in using commercially available computer software without proper understanding of the theory behind them, and that is one of the reasons to have a thorough understanding of the theory behind FEM.							
Contents							**No. of Lectures**
Module 1							

Objective of the Course, Basic Steps in FEM Formulation, General Applicability of the Method; Variational Functional, Ritz Method, Variational FEM : Derivation of Elemental Equations, Assembly, Imposition of Boundary Conditions, Solution of the Equations,	**8**
Module 2	
1 -D Elements, Basis Functions and Shape Functions, Convergence Criteria, h and p Approximations, Natural Coordinates, Numerical Integration, Gauss Elimination based Solvers, Alternate Formulation: Weighted Residual Method, Galerkin Method; Problems with C1 Continuity: Beam Bending, Connectivity and Assembly of C1 Continuity Elements	**8**
Module 3	
Variational Functional; 2-D Elements (Triangles and Quadrilaterals) and Shape Functions, Natural Coordinates, Numerical Integration, Elemental Equations, .Connectivity and Assembly, Imposition of Boundary Conditions, Axisymmetric (Heat Conduction) Problem, Plane Strain and Plane Stress Solid Mechanics Problems.	**8**
Module 4	
Sub-parametric, Iso-parametric and Super-parametric Elements; Elements with C1 Continuity, Free Vibration Problems, Formulation of Eigen Value Problem, FEM Formulation,	**7**
Module 5	
Time-dependent Problems, Combination of Galerkin FEM and FDM (Finite Difference Method), Convergence and Stability of FD Scheme, Problems with Material Non-linearity, Direct Solution Technique.	**7**
Total	**38**

Text	1) U. S. Dixit, "Finite Element Methods For Engineers", Cengage Learning Asia, 2009. 2) K. J. Bathe, "Finite Element Procedures", Prentice Hall, 1996.
Reference	1) R. D. Cook, D. S. Malkus, M. E. Plesha and R.J. witt, "Conceptsand Applications of Finite Element Analysis", 4th Edition, Wiley-India,2007

Course Code	Course name	L	T	P	C	Year	Semester
ME32X	Electric and Hybrid Vehicles	3	1	0	4	3rd	6th

Course objective: Electric and hybrid electric vehicles (EVs and HEVs) are complex mechatronic systems;their design requires holistic consideration of vehicle and tire dynamics, powertrain, electricmotors and batteries, and control and estimation modules that are integrated through each other. The students would be able to get an overview of system level modelling of Electric and Hybrid Vehicles.

Contents	No. of Lectures
Module – I	
Introduction to Vehicle Propulsion and Powertrain Technologies: History of Vehicle Development, Internal Combustion Engine Vehicles (ICEVs), Vehicles	**8**

with Alternative Fuels, Powertrain Technologies, Transmission Systems, Drivetrain and Differentials. **Electric and Hybrid Powertrain Technologies:** Introduction, Battery Electric Vehicles (BEVs), Fuel-Cell Electric Vehicles (FCEVs),	
Module – II	
Hybrid Electric Vehicles, Plug-in Hybrid Electric Vehicles (PHEVs), Hybrid Hydraulic Vehicles (HHVs), Pneumatic Hybrid Vehicles (PHVs), Power/Energy Management Systems. **Body and Chassis Technologies and Design:** Introduction, General Configuration of Automobiles, Body and Chassis Fundamentals, Different Types of Structural Systems,	**8**
Module – III	
Body and Chassis Materials, Specific Considerations in Body and Chassis Design of Electric and Hybrid Electric Vehicles, The Chassis Systems of Electric and Hybrid Electric Vehicles.	**8**
Module – IV	
Vehicle Dynamics Fundamentals: Concepts and Terminology, Vehicle Kinematics, Tire Mechanics and Modeling. **Vehicle Dynamics Fundamentals:** ICE Performance Characteristics, Electric Motor Performance Characteristics,	**8**
Module – V	
Battery Performance Characteristics, Transmission and Drivetrain Characteristics, Regenerative Braking Characteristics, Driving Cycles. **Powertrains Components:** Case Study: Introduction, Rechargeable Battery Vehicles, Hybrid Vehicles, Fuel Cell Powered Bus	**8**
Total	**40**

Text	1) A. Khajepour, S. Fallah and A. Goodarji, “Electric and Hybrid Vehicles, technologies, modeling and control: A mechatronic approach”, Willey, 2014. 2) J. Larminie and J. Lowry, “Electric vehicle technology explained”, wiley,2003.

Course Code	Course name	L	T	P	C	Year	Semester
ME32×	Advance Electrical Machine Design	3	1	0	4	3rd	6th
Course objective: The objective is to introduced basic design principle of design of electrical machines. The students would be able to understand various design consideration in designing of electrical machines							

Contents		No. of Lectures
Module 1		
Principles of Design, Factors for Consideration, Classification of Design Problem, Specifications and Standards, Constraints of Design, Dimensions and Rating of Machines, Output Equation (DC Machine, AC Machine), Materials for Electrical Machines, Heat Dissipation Modes, Types of Cooling (Ventilation), Types of Enclosure, Quantity of Coolant, Types of Duties and Ratings, Determination of Temperature Rise and Fall		**7**
Module 2		
Analysis of Series Composite Magnetic Circuit, Analysis of Parallel Composite Magnetic Circuits, Comparison Between Magnetic Circuit and Electric Circuit, Determination of Reluctance and MMF of Air Gap, Determination of MMF of Teeth, Real Flux Density and Apparent Flux Density, Iron Loss Calculation(Hysteresis Loss, Eddy Current Loss, Total Iron or Core Loss, Pulsation Loss), Magnetic Leakage, Estimation of Specific Permeance and Leakage Reactance, Magnetic Pull		**7**
Module 3		
Introduction (Based on Voltage Ratio, Based on Construction, Based on Application, Based on Number of Phases, Specifications of a Transformer, Design of Transformer(Output Equation of Single-phase Transformer, Output Equation of Single-phase Transformer (Core-type), Output Equation of Transformer, Volt Per Turn of Winding, Choice of Flux Density, Choice of Current Density, Design of Core (Square Core, Stepped Core), Design of Yoke, Overall Dimensions, Design of Windings, Resistance , Reactance Calculation, No Load Current of a Transformer, Transformer Losses, Effects of Change in Frequency in Parameters of the Transformer, Optimum Design, Mechanical Forces		**7**
Module 4		
Introduction, Construction, Design Considerations, Specifications, Output Equation, Choice of Specific Loadings, Design of stator and Rotor, Magnetic Circuit Calculations, Calculation of Resistance and Leakage Reactance, Performance Calculation		**7**
Module 5		
Elementary machines, Generated EMF, MMF of distributed ac winding, Rotating magnetic field, Torque in round rotor machine, Operation of basic machine types, Magnetic leakage in Rotating machines, Losses and Efficiency, Matching characteristics of electric machine and load, AC armature windings.		**7**
Module 6		
Design of three phase induction motor, thermal design (Losses, heat removal and thermal equivalent circuit)		**7**
	Total	**42**
Text	1) V. S. Nagarajan and V. Rajini, “Electrical Machine Design”, Pearson Publishing, 2018.	

	2) J. Pyrhonen, T. Jokinen and V. Hrabovcova, “Design of Rotating Electrical Machines”, Wiely, 2009.
Reference	3) D. P. Kothari and I. J. Nagrath, “Electric Machines”, McGrawHill, 2010.

Elective-II Course Syllabus

Course Code	Course name	L	T	P	C	Year	Semester
ME33X	Micro-manufacturing	3	1	0	4	3rd	6th

Course objective:

1. To introduce the different methods of micro-fabrication.
2. To study about the different tools of micro-fabrication.

Contents	No. of Lectures
Module : 1	
Introduction to micro-manufacturing:definition, need/importance, applications, Size effect. Classification of micro-manufacturing processes	**6**
Module : 2	
Micro-machining processes: molecular dynamics at atomistic scale, diamond micro-machining and grinding, ultrasonic micro-machining, micro-EDM, laser beam micro-machining,	**8**
Module : 3	
Micro-ECM, electron beam micro-machining, focused ion-beam techniques, Abrasive micro-finishing techniques. Micro-forming techniques: laser micro-bending, micro-deep drawing and micro-extrusion. Micro-welding and joining techniques.	**8**
Module : 4	
Micro-fabrication using deposition techniques such as epitaxial, sputtering, chemical vapor deposition (CVD) techniques and Lithography (LIGA) based techniques.	**8**
Module : 5	
Sensors and actuators for micro-manufacturing. Metrology for micro-manufacturing. Introduction to nano-scalemanufacturing	**8**
Total	**38**

Text	1. V.K. Jain, "Micromanufacturing Processes", Taylor and Francis, 2012. 2. J. McGeough, "Micromachining of Engineering Materials", Marcel Dekker,2002.
Reference	1. K. F. Ehmann, "Micromanufacturing: International Assessment of Research and Development", Springer, 2007. 2. P. Raichoudhury, "Handbook of Microlithography, Micromachining and Microfabrication", 1997.

Course Code	Course name	L	T	P	C	Year	Semester
ME33X	Introduction to Composite Materials	3	1	0	4	3rd	6th

Course objective:

1. Introduce to advanced composite materials and their applications.
2. Develop fundamental relationships for predicting the mechanical and hygrothermal response of multi layered materials and structures.
3. Develop macro-mechanical relationships for lamina and laminated materials.

Contents	No. of Lectures
Module : 1	
Classifications, terminologies, manufacturing processes (in brief).	**6**
Module : 2	
Macro-mechanicalanalysis of lamina, Hooke's law for anisotropic, monoclinic, orthotropic,transversely isotropic and isotropic materials, 2D Unidirectional and angle ply lamina , Strength theories of lamina. Micromechanical analysis of lamina	**8**
Module : 3	
Volume and mass fraction, density and void content –Evaluation of Elastic modulii, Ultimate strength of unidirectional lamina. Macro-mechanical analysis of laminates – Laminate code, Stress strain relations –In-plane and Flexural modulus,Hygrothermal effects. Failure Analysis and Design, Special cases of laminates, symmetric, cross ply, angle ply and antisymmetric laminates,	**8**
Module : 4	
Stress strain relations –In-plane and Flexural modulus, Hygrothermal effects. Failure Analysis and Design, Special cases of laminates, symmetric, cross ply, angle ply and antisymmetric laminates,	**6**

Module : 5	
Failure criteria and failure modes.Establish the failure criteria for laminates based on failure of individual lamina in a laminate.	**8**
Total	**36**

Text	1. R. M. Jones, Mechanics of Composite Materials, Scripta Book Co. 2. B. D. Agarwal, and J. D. Broutman, "Analysis and Performance of Fiber Composites", New York, John Willey and Sons, 1990
Reference	1. K. Kaw Arthur, "Mechanics of Composite Materials", CRC Press, 1997. 2. P, K. Mallik, "Fiber reinforced composites : materials, manufacturing and design", New York-Marcel and Dekker, 1993 (2nd edition)

Course Code	Course name	L	T	P	C	Year	Semester
MAXXX	Scientific Computation	3	0	2	4	3rd	6th

Course objective: The course provides an overview of the foundations of techniques needed to solve a differential equation in engineering disciplines

Topic	Contents	No. of Lectures
Module-I	Errors; Iterative methods for nonlinear equations; Polynomial interpolation, spline interpolations; Numerical integration based on interpolation, quadrature methods, Gaussian quadrature	**08**
Module-II	Initial value problems for ordinary differential equations - Euler method, Runge-Kutta methods, multi-step methods, predictor-corrector method, stability and convergence analysis;	**08**
Module-III	Finite difference schemes for partial differential equations - Explicit and implicit schemes	**09**
Module-IV	Consistency, stability and convergence; Stability analysis (matrix method and von Neumann method), Lax equivalence theorem	**08**
Module-V	Finite difference schemes for initial and boundary value problems (FTCS, Backward Euler and Crank-Nicolson schemes, ADI methods, Lax Wendroff method, upwind scheme).	**09**
	Total	**42**

Text	1. D. Kincaid and W. Cheney, Numerical Analysis: Mathematics of Scientific Computing, 3rd Ed., AMS, 2002. 2. G. D. Smith, Numerical Solutions of Partial Differential Equations, 3rd Ed., Calrendorn Press, 1985.
References	1. K. E. Atkinson, An Introduction to Numerical Analysis, Wiley, 1989. 2. S. D. Conte and C. de Boor, Elementary Numerical Analysis - An Algorithmic Approach, McGraw-Hill, 1981.

Course Code	Course name	L	T	P	C	Year	Semester
ME33X	Optimization Methods in Engineering	3	1	0	4	3rd	6th

Course objective:

Optimization is the process of obtaining the best result under given circumstances. In design,construction and maintenance of any engineering system, engineers have to take many technological and managerial decisions at several stages. The ultimate goal of all such decisions is either to minimize the effort required or to maximize the desired benefit. The objective is to introduce number of optimization methods developed for solving different types of optimization problem.

Contents	No. of Lectures
Module 1	
Introduction and Basic Concepts: Historical Development; Engineering applications of Optimization; Art of Modeling, Objective function; Constraints and Constraint surface; Formulation of design problems as mathematical programming problems, Classification of optimization problems, Optimization techniques –classical and advanced techniques.	**8**
Module 2	
Optimization using Calculus: Stationary points; Functions of single and two variables; Global Optimum, Convexity and concavity of functions of one and two variables, Optimization of function of one variable and multiple variables; Gradient vectors; Examples, Optimization of function of multiple variables subject to equality constraints; Lagrangian function Optimization of function of multiple variables subject to equality constraints; Hessian matrix formulation; Eigen values, Kuhn-Tucker Conditions; Examples	**8**
Module 3	
Linear Programming:.Standard form of linear programming(LP) problem; Canonical form of LP problem; Assumptions in LP Models; Elementary operations, Graphical method for two variable optimization problem; Examples, Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Simplex criterion; Minimization versus maximization problems, Revised simplex method; Duality in LP; Primal-dual relations; Dual Simplex, method; Sensitivity or post optimality analysis, Other algorithms for solving LP problems – Karmarkar's projective scaling method	**8**
Module 4	
Linear Programming Applications: Use of software for solving linear optimization problems using graphical and simplex methods, Examples for transportation, structural and other optimization problems.	**8**
Module 5	
Dynamic Programming: Sequential optimization; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle	**8**

of optimality, Recursive equations –Forward and backward recursions; Computational procedure in dynamic programming(DP), Discrete versus continuous dynamic programming; Multiple state variables; curse of dimensionality in DP	
Total	**38**

Text/ Reference	1) S. S. Rao, "Engineering Optimization: Theory and Practice", New Age International P. Ltd.,New Delhi, 2000 2) H. A. Taha, "Operations Research: AnIntroduction", 5th Edition, Macmillan, New York,1992.
Reference	1) K. Deb, "Optimization for Engineering Design-Algorithms and Examples", Prentice-Hall of India Pvt. Ltd., New Delhi, 1995

Course Code	Course name	L	T	P	C	Year	Semester
ME33X	MEMS and NEMS	3	1	0	4	3rd	6th

Course objective: This course provides a rigorous grounding in the theory and practice of MEMS design, as well as ways of extending them to NEMS design. It will enable you to build MEMS by design not trial and error. It will also give you the analytical tools to explore the possibilities of NEMS.

Topic	Contents	No. of Lectures
Module-1	Overview and Introduction: New trends in Engineering and Science: Micro and Nano scale systems Introduction to Design of MEMS and NEMS, Overview of Nano and Micro electromechanical Systems, Applications of Micro and Nano electromechanical systems, Micro electromechanical systems, devices and structures Definitions, Materials for MEMS: Silicon, silicon compounds, polymers, metals	**09**
Module-2	MEMS Fabrication Technologies: Microsystems fabrication processes: Photolithography, Ion Implantation, Diffusion, Oxidation. Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect-Ratio (LIGA and LIGA-like) Technology; Packaging: Microsystems packaging, Essential packaging technologies, Selection of packaging materials	**09**
Module-3	Micro Sensors: MEMS Sensors: Design of Acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezo Resistive Pressure sensors- engineering mechanics behind these Micro sensors. Case study: Piezo-resistive pressure sensor	**08**
Module-4	Micro Actuators: Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb drive actuators), Micromechanical Motors and pumps. Case study: Comb drive actuators	**08**
Module-5	Nano-systems And Quantum Mechanics: Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrödinger Equation	**08**

	and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits	
	Total	**42**
Text	1. Tai Ran Hsu, *MEMS and Microsystems Design and Manufacture*, Tata McGraw Hill, 2002. 2. S. E. Lyshevski, *MEMS and NEMS: Systems, Devices, and Structures*, CRC Press, 2002.	

Course Code	Course name	L	T	P	C	Year	Semester
ME33X	Power Electronics	3	1	0	4	3rd	6th

Course objective:
The objective of this course is to present the principles of power electronics and its applications. This includes power electronics circuits, power semiconductor devices, and converter topologies. The student will learn analysis and design techniques for switch-mode converters using the buck, boost, and buck-boost topologies.

Contents	No. of Lectures
Module 1	
Introduction: Concept of Power Electronics, Different types of power electronics devices, converter systems, areas of application, recent developments **Device characteristics, protection and operation:** Terminal characteristics of major power electronics devices, ratings, protection, heating, cooling and mounting, series and parallel operation, firing circuits	**9**
Module 2	
Phase controlled rectifiers: Principles of operation of phase controlled, single phase & poly-phase, full-wave & half-wave converters with continuous and discontinuous load currents and harmonic analysis. Effect of source impedance on the performance of converters, dual converters	**9**
Module 3	
Choppers: Principle of chopper operation, Control strategies, Types of chopper circuits and steady state analysis. Commutation in chopper circuits, Multiphase chopper.	**8**
Module 4	
Inverters: Classification of inverters, Single-phase and three-phase Voltage source Inverters, Methods of controlling output voltage, frequency and phase, Reduction of harmonics in the inverter output voltage, Current source inverters and operations.	**9**
Module 5	
AC Voltage Controller: Types of AC voltage controllers, Single phase voltage controllers, Sequence control of ac voltage controllers, 3-phase AC voltage controller operation **Cycloconverters:** Principles of cycloconverter operation, Methods of controlling output voltage and frequency in cases of: Single phase to single phase, three phase to single phase, three phase to three phase operation.	**10**
Total	**45**

Text/ Reference	1) E. Maksimovic, “Fundamentals of Power Electronics”, 2001 2) N. Mohan, T. M. Undeland and W. P. Robbins, “Power Electronics: Converters, Applications and Design”, Wiley, 1995.