INDIAN INSTITUTE OF INFORMATION TECHNOLOGY BHAGALPUR

B.Tech. Course Structure for 2021 - 2025 Batch

Mechatronics Engineering (MEA)

Course Code	Course name	L	T	P	C	Year	Semester	Semester total credit
MA101	Engineering Mathematics – I	3	1	0	4	1	1	23
PH101	Engineering Physics	3	0	0	3			
EC101	Electrical Sciences	3	0	0	3			
CS101	Computer Programming	3	0	0	3			
HS101	Professional Communication	2	0	0	2			
ME102	Engineering Graphics	2	0	3	4			
EC112	Electrical Sciences Lab	0	0	3	2			
CS110	Computer Programming Lab	0	0	3	2			
MA102	Engineering Mathematics – II	3	1	0	4	1	2	23
CS102	Data Structures and Algorithms	3	0	0	3			
EC102	Digital Design	3	0	0	3			
EC104	Semiconductor Devices and Circuits	3	0	0	3			
ME101	Engineering Mechanics	3	1	0	4			
CS112	Data Structure and Algorithm Lab	0	0	3	2			
EC113	Digital Design Lab	0	0	3	2			
EC114	Semiconductor Devices and Circuits Lab	0	0	3	2			
Society Academia Industry Internship								
MA201	Engineering Mathematics III	3	1	0	4	2	3	25
ME201	Solid Mechanics	3	0	2	4			
HS201	Management Concepts and Technology	2	0	0	2			
CS203	Object Oriented Programming	3	0	0	3			
ME202	Thermodynamics	3	0	0	3			
ME203	Electrical Machine	3	0	2	4			
CS211	Object Oriented Programming Lab	0	0	3	2			
ME211	Mechanical Workshop	0	0	3	2			
SAI-I	**Society Academia Industry Internship - I**	0	0	0	1			
EC203	Analog Electronics	3	0	0	3	2	4	25
MA203	Probability and Statistics	3	1	0	4			
ME204	Design of Machine Elements	3	0	0	3			
ME205	Kinematics of Machines	3	0	0	3			
ME206	Manufacturing Science	3	0	2	4			
ME207	Fluid Mechanics	3	1	0	4			
EC215	Analog Electronics LAB	0	0	3	2			
ME212	Simulation Lab	0	0	3	2			
Society Academia Industry Internship								

Course Code	Course name	L	T	P	C	Year	Semester	semester total credit
EC301	Digital Signal Processing	3	0	0	3	3	5	25
EC302	Control Systems	3	1	0	4			
ME301	Dynamics of Machinery	3	0	0	3			
ME302	Sensors and Actuators	3	0	0	3			
CS303	Artificial Intelligence	3	0	2	4			
EC304	IOT and Embedded System	3	0	0	3			
EC311	Digital Signal Processing Lab	0	0	3	2			
EC312	IOT and Embedded System LAB	0	0	3	2			
SAI-II	Society Academia Industry Internship – II	0	0	0	1			
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								
HS401	Professional Ethics for Engineers	2	0	0	2	4	7	22
ME42X	Elective – III	3	1	0	4			
ME42X	Robotics	3	0	0	3			
XX4XX	Open Elective	3	1	0	4			
HS45X	Foreign Language	0	0	2	2			
ME411	Robotics Lab	0	0	3	2			
ME491	Minor Project	0	0	0	4			
SAI-III	**Society Academia Industry Internship-III**	0	0	0	1			
ME492	BTech/Research/Industry Project	3	0	0	16	4	8	16

Total Credit: 180

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

Elective III

Semester	Area	Subject
VII	Mechatronics (Mechanical)	Mechanical Vibration, Computer Integrated Manufacturing
VII	Computation	Introduction to Data Science, Reinforcement Learning
VII	Mechatronics (Electrical)	Electro-mechanics and Magnetic Propulsion, Automobile Engineering

Open Elective

1. Quality Control.
2. Advanced Robotics.
3. Materials Characterizations Methods.
4. Physics of Manufacturing.

MEA Course Syllabus First Semester Onwards

Course Code	Course name	L	T	P	C	Year	Semester
MA101	Engineering Mathematics I	3	1	0	4	1st	1st
Topic	**Contents**						**No. of Lectures**
Module-I	Matrices and solving system of linear equations: Gauss elimination method, Elementary Row operations, Elementary matrices, Invertible matrices, Gauss-Jordon method for finding the inverse of a matrix; Determinants, Basic properties of determinants; Cofactors and Adjoints, the Determinant method for finding the inverse of a matrix, Cramer's Rule; Vector space, Subspace, Linear span, Linear independence and dependence, Basis, Dimension, Extension of a bas is of a subspace, Intersection, and the sum of two subspaces. The rank of a matrix, Row and column spaces, Solvability of a system of linear equations.						**09**
Module-II	Inner Product Space, Orthogonal projection, Orthogonal complement, Orthogonal basis of a Vector Space, Gram-Schmidt orthogonalization process. Least Square Method; Eigenvalue, Eigen Vectors, Matrix Diagonalization, Similarity Transformation.						**08**
Module-III	Co-ordinate of a Vector, Change of Basis; Linear transformation, Kernel, and Range of a linear map, Rank-Nullity Theorem, Matrix of a Linear Transformation; Point set Theory: Real Number system, Open and Closed Set, Intervals; Sequences of Real Numbers: Monotonicity, Convergence tests, Cauchy Criterion, Subsequences; Limits and Continuity of a real function, Boundedness of a continuous function on a closed interval, Uniform continuity.						**08**
Module-IV	Differentiability, Rolle's theorem and Mean Value theorems, Taylor's theorem, L `Hospital rule, Increasing and decreasing function, Convexity, Second derivative test for max and min, Point of Inflection; Series of real Numbers: Partial Sum Sequence, Convergence of series, Geometric and Harmonic Series, Absolute convergence, Comparison test, Ratio test, Root test, Cauchy Condensation test; Power series, Radius of convergence, Taylor Series, Maclaurin Series.						**09**
Module-V	Introduction to Riemann Integration, Integrability, The Integral existence theorem for continuous functions and monotone functions, Elementary properties of integral, Fundamental theorems of Calculus; Improper integral of the first and the second kind, Comparison test, Absolute convergence. Introduction to Beta and Gamma Function; Application of Integration to length, area, volume and surface area of revolution						**08**
						Total	**42**
Text	1. B S Grewal, J S Grewal, J K Dhanoa, *Higher Engineering Mathematics*, Khanna Publishers, 44th edition, 2017. 2. E. Kreyszig, H. Kreyszig, E. J. Norminton, *Advanced Engineering Mathematics*, 10th, Wiley India Pvt. Ltd., 2017						
Reference	1. D. Poole, *Linear Algebra*: *A Modern Introduction*, 4th edition, Brooks Cole, 2014. 2. S. R. Ghorpade and B. V. Limaye, *A Course in Calculus and Real Analysis*, 1st edition, Springer India, 2006.						

Course Code	Course name	L	T	P	C	Year	Semester
PH101	Engineering Physics	3	1	0	4	1st	1st
Topic	**Contents**						**No. of Lectures**
Module-I	Laws of thermodynamics- Statement, Discussion and Significance of Zeroth, First and Second law, Isothermal and Adiabatic change & Carnot cycle.						**08**
Module-II	Concept of Entropy- Clausius inequality and the physical significance of Entropy; Matter Waves, Wave and Group Velocities, Heisenberg Uncertainty Principle						**08**

Module-III	Wave Function, its Interpretation and Normalization, Superposition of Amplitudes, Dynamical Variables as Operators, Expectation Values, Schrodinger Equation and its Simple Applications like Particle in a Box.	**10**
Module-IV	Semiconductor materials, insulators, intrinsic and extrinsic semiconductor, Carrier transport in a semiconductor: diffusion current, drift current, mobility, and resistivity. Generation and recombination of carriers in semiconductors.	**08**
Module-V	Electrons and Holes in semiconductors: Donors and acceptors in the band model, electron effective mass, Density of states, Thermal equilibrium, Fermi-Dirac distribution function for electrons and holes, Fermi energy. Equilibrium distribution of electrons & holes.	**08**
	Total	**42**
Text	1. Dattu R Joshi, *Engineering Physics*, Tata McGraw Hill Education, 1st edition, 2015. 2. D K Bhattacharya, Poonam Tandon, *Engineering Physics*, Oxford University Press India; 2017.	
Reference	1. Arthur Beiser, Shobhit Mahajan, S Rai Choudhury, *Concepts of Modern Physics*, Tata McGraw Hill Education, 7th edition, 2017. 2. David J Griffiths, *Introduction to Quantum Mechanics*, Pearson India Education Services Pvt. Ltd, 2nd edition, 2018.	

Course Code	**Course name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
EC101	Electrical Science	3	0	0	3	1st	1st

Course objective: The main objective of this course is to analysis of resistive circuits and solution of resistive circuits with independent sources, two terminal element relationships for inductors and capacitors and analysis of magnetic circuits, analysis of single phase AC circuits, the representation of alternating quantities and determining the power in these circuits, etc.

Topic	**Contents**	**No. of Lectures**
Module-I	Basic components and electric circuits, Ohm's law, nodes, paths, loops and branches, Kirchhoff's current law, Kirchhoff's voltage law, dependent and independent sources, voltage and current division, Basic nodal and mesh analysis; supernode, supermesh	**04**
Module-II	Network theorems: linearity and superposition, source transformations, Thevenin and Norton equivalent circuits, maximum power transfer; RL and RC circuits: source-free RL circuit, source-free RC circuit, unit-step function, driven RL circuits, natural and forced response, driven RC circuits	**10**
Module-III	RLC circuit: source-free parallel circuit, overdamped parallel RLC circuit, critical damping, underdamped parallel RLC circuit, source-free series RLC circuit, complete response of the RLC circuit	**09**
Module-IV	Sinusoidal steady-state analysis: forced response to sinusoidal functions, complex forcing function, phasor, phasor relationship for R, L and C, impedance, admittance, phasor diagrams, instantaneous power, average power, apparent power and power factor, complex power; Polyphase circuits: polyphase systems, single-phase three-wire systems, three-phase Y-Y connection, delta connection, power measurement in three-phase systems	**10**
Module-V	Magnetically coupled circuits: mutual inductance, energy considerations, Transformers, Principle of transformers and rotating machine, D. C machine: D. C. Motor and generator; Two-port networks: one-port networks, admittance parameters, impedance parameters, hybrid parameters, transmission parameters.	**09**
	Total	**42**
Text	1. W. H. Hayt, J. E. Kemmerly, S. M. Durbin, *Engineering Circuit Analysis*, Tata-McGraw-Hill Publishing Company Limited, 8th edition,2012. 2. E. Hughes, J. Hiley, I. McKenzie-Smith, K. Brown, *Electrical And Electronic Technology*, Pearson Education India, 10th edition, 2010.	
Reference	1. Bruce Carlson, *Circuits: Engineering Concepts and Analysis of Linear Electric Circuits*, Thomson Asia Pvt. Ltd., 2nd edition Reprint, 2006.	

Course Code	Course name	L	T	P	C	Year	Semester
CS101	Computer Programming	3	0	0	3	1st	1st

Course objective: This course aims to teach everyone the basics of programming computers using C Programming Language. We cover the basics of how one constructs a program from a series of simple instructions in C language.

Topic	Contents	No. of Lectures
Module-I	Introduction to Computing: Historical perspective, Early computers, the von Neumann architecture. Problems, Pseudo code, and Flowchart. Memory, Variables, Values, Instructions, Programs. Assembly language, High level language, Compiler, Assembler, Operating Systems.	**08**
Module-II	Introduction to C: The C language. Phases of developing a running computer program in C; Data Concepts in C: Constants, Variables, Expressions, Operators, and operator precedence in C. Managing input and output statements, Sequential control statements, Decision making statements (If Else constructs), Loop control statements (While construct, Do While construct, For construct).	**08**
Module-III	Data Types in C: Different basic data types and their sizes. One-dimensional Arrays: Declaration and initialization, Two-dimensional Arrays: Declaration and initialization, Multidimensional Arrays. String variables, Reading and writing strings, Arithmetic operations on characters, Putting strings together, Comparison of two strings.	**09**
Module-IV	Modular Programming and Example Programs: Functions: The prototype declaration, Function definition. Function call: Passing arguments to a function (by value, by reference). Scope of variables. Recursive function calls, Tail recursion, Tree of recursion. Sorting problems: Selection sort, Insertion sort. Sorting in arrays. Search problems: Linear search and binary search. Recursive and iterative formulations; More Data Types in C: Pointers: Declaring and dereferencing pointer variables. Pointer arithmetic. Accessing arrays. through pointers. Pointer types, Pointer and strings.	**10**
Module-V	Structures in C: Motivation, examples, declaration, and use. Operations on structures. Passing structures as function arguments. Type defining structures. Self-referential structures, Linked lists with examples. File operations in C: Input, output, and error streams. Opening, closing, and reading from files. Searching through files using functions such as fseek(), ftell(), and rewind(). Programming for command line arguments.	**07**
	Total	**42**
Text	1. Bryon Gottfried, *Programming with C*, Tata-McGraw-Hill, 3rd edition, 2015.	
Reference	1. Kernighan and Ritchie, *The C Programming Language*, PHI, 2nd edition, 2017. 2. H. M. Deitel, P. J. Deitel, *C: How to program*, Pearson Education, 7th edition, 2010.	

Course Code	Course name	L	T	P	C	Year	Semester
HS101	Professional Communication	2	0	0	2	1st	1st

Topic	Contents	No. of Lectures
Module-I	Communication Fundamentals: Using Verbal and Non- verbal Communication	**03**
Module-II	Interviewing Principles And Skills: Fundamental principles of interviewing, Success in an interview, Types of Interviews, Important Non-verbal aspects	**04**
Module-III	GROUP DISCUSSIONS: Methodology of GD, Improving Group performance	**04**
Module-IV	Professional Writing: Kinds of business letters, Job Applications and Resume Writing, Report Writing, Proposal layout and design, E-mail etiquette, Notices, Agenda and Minutes	**05**

Module-V	Delivering Professional Presentations: Elements of effective English, Effective paragraphs, The power of reading, Punctuation and Capitalization	**04**
	Total	**20**
Text	1. Business Correspondence and Report Writing - R. C. Sharma 2. Business Communication - M. Balasubramanyam 3. Essentials of Business Communication - R. Pal and Kolahalli 4. Business Communication and Report Writing - Sharma, Mohan 5. Lesikar's Basic Business Communication – Lesikar	

Course Code	**Course name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
ME101	**Engineering Graphics**	2	0	3	4	1st	1st

Course objective:

1. To understand the drawing importance in engineering
2. To describe the 3D objects into different 2D views.
3. To understand the application of company standards and techniques applied in engineering graphics
4. To represent engineered parts by use of auxiliary or sectional views.

Contents	**No. of Lectures**
Module 1	
Introduction and importance of engineering drawing, Drawing techniques: manual drawing and computer-aided drawing, Drawing instruments and their uses. Conventions of ISO and BIS, Layout of drawing sheets, Border lines, Title block, Folding of drawing sheets, Lines. **Scales:** Requirements, Plane scale, Diagonal and vernier scales. **Geometrical construction and curves:** Definitions of ellipse, Parabola and hyperbola, Various methods of drawing Ellipse, parabola and hyperbolaand drawing tangents and normal at any point on the conic.	**6**
Module 2	
Cycloids, Construction of cycloids, Epicycloids & hypocycloid. Involutes, Spirals and Helices and their construction. **Orthographic projection:** Introduction, Methods of projection, Orthographic projection, Projection planes and four quadrants, First and third angle projections. **Projection of points:** Introduction, A point is situated in the first, second, third and fourth quadrant. **Projection of straight lines:** Introduction, Line parallel to one or both of the planes, Line perpendicular to one of the planes, Line inclined to one and perpendicular to other, Line inclined to both of the planes, True lengths and its inclination, Traces of a line.	**6**
Module 3	
Projection of planes: Introduction, Types of planes, Traces of planes and its calculations, Projection of planes parallel to one of the reference planes, Projection of planes inclined to one reference planes and perpendicular to other, Projection of oblique planes. Projection of lines and plane by auxiliary planes.	**6**

Projection of solids: Introduction, Types of solids, Projections of solids in simple positions, Projections of solids with axes inclined to one of the reference planes and parallel to other, Projections of solids with axes inclined to both of the planes, Projection of spheres.	
Module 4	
Projection of sectioned solids: Introduction, Conventions in sectional view drawings, True shape of a section, Sections of prisms, pyramids, cylinders, cones and spheres. **Intersection of solids:** Introduction, Classification, Line of intersection, Line/generator method and section plane method, Intersection of two prisms, two cylinders, cone and cylinder, pyramid and cylinder, pyramid and prism, etc. **Development of surfaces:** Introduction, Method of development, Development of lateral surfaces of right solids, Development of transition pieces, Development of spheres.	**6**
Module 5	
Isometric: Introduction, Isometric scale, Box method, Coordinate or offset method, Four centre method, Isometric projection of arcs, Construction of isometric projection of different solids. **Perspective projection:** Introduction, Terminology and Principles of perspective projection. Methods of perspective projection of various objects.	**4**
Total	**30**

Text	1. N. D. Bhatt and V. M. Panchal, "Engineering Drawing", 53rd Ed., Charator Publishing House,2001 2. M. B. Shah and B. C. Rana, "Engineering Drawing", 2nd Ed., Pearson Education, 2009
Reference	1) T. E. French, C. J. Vierck and R. J. Foster, "Graphic Science and Design", 4th Ed., McGraw Hill, 1984. 2) W. J. Luzadder and J M Duff, "Fundamentals of Engineering Drawing", 11th Ed., PHI,1995

Course Code	Course name	L	T	P	C	Year	Semester
MA102	Engineering Mathematics II	3	1	0	4	1st	2nd
Topic	**Contents**						**No. of Lectures**
Module-I	Vector functions of one variable – continuity, differentiation and integration; Functions of several variables - continuity, partial derivatives, directional derivatives, gradient, differentiability, chain rule; tangent planes and normal; Concavity-Convexity, Maxima and minima, Saddle Pont, Lagrange multiplier method.						**09**
Module-II	Repeated and Multiple integrals with applications to volume, surface area, Moments of Inertia, change of variables, Vector Fields, Line and Surface Integrals.						**08**
Module-III	Green's, Gauss' and Stokes' theorems and their applications; First order differential equations - exact differential equations, integrating factors, Bernoulli equations, existence and uniqueness theorem, applications						**08**
Module-IV	Higher-order linear differential equations, solutions of homogeneous and non-homogeneous equations, method of variation of parameters. Series solutions of linear differential equations. Legendre equation and Legendre polynomials. Bessel equation and Bessel functions of first and second kinds.						**09**
Module-V	Systems of first-order equations, two-dimensional linear autonomous system, phase plane, critical points, stability.						**08**
						Total	**42**

Text	1. B S Grewal, J S Grewal, J K Dhanoa, *Higher Engineering Mathematics*, Khanna Publishers, 44th edition, 2017. 2. E. Kreyszig, H. Kreyszig, E. J. Norminton, *Advanced Engineering Mathematics*, 10th, Wiley India Pvt. Ltd., 2017
Reference	1. D. Poole, *Linear Algebra*: *A Modern Introduction*, 4th edition, Brooks Cole, 2014. 2. S. R. Ghorpade and B. V. Limaye, *A Course in Calculus and Real Analysis*, 1st edition, Springer India, 2006.

Course Code	**Course name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
MA102	Engineering Mathematics II	3	1	0	4	1st	2nd

Topic	**Contents**	**No. of Lectures**
Module-I	Vector functions of one variable – continuity, differentiation and integration; Functions of several variables - continuity, partial derivatives, directional derivatives, gradient, differentiability, chain rule; tangent planes and normal; Concavity-Convexity, Maxima and minima, Saddle Pont, Lagrange multiplier method.	**09**
Module-II	Repeated and Multiple integrals with applications to volume, surface area, Moments of Inertia, change of variables, Vector Fields, Line and Surface Integrals.	**08**
Module-III	Green's, Gauss' and Stokes' theorems and their applications; First order differential equations - exact differential equations, integrating factors, Bernoulli equations, existence and uniqueness theorem, applications	**08**
Module-IV	Higher-order linear differential equations, solutions of homogeneous and non-homogeneous equations, method of variation of parameters. Series solutions of linear differential equations. Legendre equation and Legendre polynomials. Bessel equation and Bessel functions of first and second kinds.	**09**
Module-V	Systems of first-order equations, two-dimensional linear autonomous system, phase plane, critical points, stability.	**08**
	Total	**42**

Text	3. B S Grewal, J S Grewal, J K Dhanoa, *Higher Engineering Mathematics*, Khanna Publishers, 44th edition, 2017. 4. E. Kreyszig, H. Kreyszig, E. J. Norminton, *Advanced Engineering Mathematics*, 10th, Wiley India Pvt. Ltd., 2017
Reference	3. D. Poole, *Linear Algebra*: *A Modern Introduction*, 4th edition, Brooks Cole, 2014. 4. S. R. Ghorpade and B. V. Limaye, *A Course in Calculus and Real Analysis*, 1st edition, Springer India, 2006.

Course Code	**Course Name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
CS102	Data Structures and Algorithms	3	0	0	3	1st	2nd

Course Objective: A good algorithm usually comes together with a set of good data structures that allow the algorithm to manipulate the data efficiently. In this course, students will get to know various data structures that are used in various computational problems.

Topic		Hour
Module I	Performance of algorithms: space and time complexity, asymptotics, lower and upper bounds.	7
Module II	Fundamental Data structures: arrays, linked lists, matrices, stacks, queues, binary trees, tree traversals.	7
Module III	Algorithms for sorting and searching: linear search, binary search, insertion-sort, selection sort, bubble sort, quicksort, mergesort, heapsort; Priority Queues: lists, heaps.	7
Module IV	Hashing: separate chaining, linear probing, quadratic probing; Search Trees: binary search trees, B-trees.	6
Module V	Graphs: Data Structures for Graphs, Breadth First Search, Depth First Search.	8
	Total	35
Text	1. Data Structures with C; Seymour Lipschutz, ; 1st, McGraw Hill Education (India) Pvt. Limited; 2011.	

	2. Data Structures Using C, Aaron M. Tenenbaum, Yedidyah Langsam, and Moshe J. Augenstein, Prentice-Hall, Inc., 2008
Reference	1. Fundamentals of Data Structures in C; Ellis Horowitz, Sartaj Sahni, Susan Anderson; 2nd, Universities Press (India) Private Limited; 2017. 2. Introduction to Algorithms; Thomas H Cormen, Charles E Leiserson, Ronald L Rivest; 3rd, PHI Learning Private Limited; 2018.

Course Code	Course name	L	T	P	C	Year	Semester
EC102	Digital Design	3	0	0	3	1st	2nd

Course objective: The main objective of this course is to introduce the number system, elements of digital system abstractions such as digital representations of information, logic gates, combinational and sequential circuits, Boolean algebra, state elements and finite state machine (FSMs).

Topic	Contents	No. of Lectures
Module-I	Number Systems and Codes, Positional number system, Binary, octal and hexadecimal number systems; Methods of base conversions; Binary, octal and hexadecimal arithmetic; Representation of signed numbers; Fixed and floating point numbers; Binary coded decimal codes; Gray codes; Error detection and correction codes - parity check codes and Hamming code	**06**
Module-II	Combinatorial Logic Systems: Definition and specification; Truth table; Basic logic operation and logic gates; Boolean Algebra and Switching Functions: Basic postulates and fundamental theorems of Boolean algebra; Standard representation of logic functions - SOP and POS forms; Simplification of switching functions - K-map and Quine-McCluskey tabular methods; Synthesis of combinational logic circuits	**10**
Module-III	Logic Gates, Two-level realizations using gates -AND-OR, OR-AND, NAND-NAND and NOR-NOR structures; Multifunction gates, Multi-bit adder, Multiplexers, DE-multiplexers, Decoders, Programmable ALU; Multiplexer-based realization of K-maps; Combinational circuit design using multiplexers and gates	**09**
Module-IV	Sequential Logic systems: Latches and Flip-flops, Timing hazards and races; Analysis of state machines using D flip-flops and JK flip-flops; Synchronous and Asynchronous counters; Registers; Sequence generator using flip-flops; Design of state machines-state table, state assignment, transition/excitation table, excitation maps and equations, logic realization; Design examples	**10**
Module-V	Memory: Read-only memory, read/write memory-SRAM and DRAM; TTL, MOS, interfacing between logic families; RAM, ROM, PAL, and PLA.	**07**
	Total	**42**
Text	1. M. Morris Mano, *Digital Logic and Computer Design*, Pearson Education, 11thedition, 2009. 2. R. Tokheim, *Digital Electronics: Principles and Applications*, Tata McGraw Hill, 6th edition, 2017.	
Reference	1. R. J. Tocci, N. S. Wisdmer and G. L. Moss, *Digital Systems: Principle and Applications*, Pearson Education, 10th edition, 2011. 2. John F Wakerly, *Digital Design: Principles And Practices*, Pearson Education, 4th edition, 2008.	

Course Code	Course name	L	T	P	C	Year	Semester
EC103	Semiconductor Devices & Circuits	3	0	0	3	1st	2nd

Course objective: The main objective of this course is to study semiconductor materials and transport mechanism, semiconductor diodes, bipolar transistors, field effect devices and transistors. More particularly, the course objectives are to:

1. Introduce students to the physics of semiconductors and the inner working of semiconductor devices.
2. Provide students the insight useful for understanding new semiconductor devices and technologies.

Topic	Contents	No. of Lectures
Module-I	Introduction of semiconductors, equilibrium and carrier concentration in semiconductors; Bond model and band model of intrinsic semiconductors, Density of state, Fermi-dirac distribution function; Carrier transport in semiconductors, Mobilty, resistivity and conductivity; Excess carrier, method of generating excess carrier inside extrinsic semiconductors. Doping and diffusion process.	**08**
Module-II	P-N Junction: Simplified device structure and physical operation of diode; depletion region, forward and reverse-bias, depletion and diffusion capacitances, switching characteristics; breakdown mechanisms; Zener diode, Tunnel diode; Diode Applications: Half Wave and Full Wave Rectifier, Clippers and Clampers, and Zener Regulators	**09**
Module-III	Simplified device structure and physical operation of BJT, I-V characteristics of BJT, carrier distribution; current gain, transit time, secondary effects; SPICE model. Metal-semiconductor junctions, Breakdown of the junction with the non-impact and impact ionization, β-I_C characteristics curve, variation of α with I_c; Small signal equivalent circuit, BJT Amplifiers: Transistor Configuration analysis, Common base, Common emitter and Common collector	**08**
Module-IV	MOS structure, Energy band diagrams, Flat-band condition and flat-band voltage, Surface accumulation, surface depletion, Threshold condition and threshold voltage, MOS C-V characteristics, MOS Q-V Characteristics.	**08**
Module-V	Introduction to Field effect transistors, Construction and characteristics of Junction Field effect transistors; N-channel and p-channel JFET characteristics; MOSFETS: Enhancement type and depletion type of MOSFET, Basic Operation and Characteristics; N-channel and P-channel MOSFET characteristics	**09**
	Total	**42**
Text	1. R. F. Pierret, *Semiconductor Device Fundamentals*, Pearson Education, 1st edition, 2006. 2. B. G. Streetman and S. K. Banerjee, *Solid State Electronic Devices*, Pearson Education, 7th edition, 2015. 3. A. S. Sedra, K. C. Smith and A. N. Chandorkar, *Microelectronics circuits*, Oxford university Press India, International Version 7th edition, 2017.	
Reference	1. J. Singh, *Semiconductor Devices - Basic Principles*, John Wiley & Sons Inc., 1st edition, 2001.	

Course Code	Course name	L	T	P	C	Year	Semester
ME102	Engineering Mechanics	3	1	0	4	1st	2nd

Course objective:

1. The primary purpose of the study of engineering mechanics is to develop the capacity to predict the effects of force and motion while carrying out the creative design functions of engineering.
2. This capacity requires more than a mere knowledge of the physical and mathematical principles of mechanics.
3. The ability to visualize physical configurations in terms of real materials, actual constraints, and the practical limitations which govern the behaviour of machines and structures.

Contents	No. of Lectures
Module : 1	
Equivalent force systems; free-body diagrams; degrees of freedom; equilibrium equations;	**10**
Module : 2	
Analysis of determinate trusses and frames; properties of surfaces friction.	**8**
Module : 3	
Centroids and centres of gravity, Moment of Inertia; Virtual work principal	**10**
Module : 4	
Equations of motion; work-energy and impulse-momentum principles; Generalized coordinates; Lagrangian mechanics.	**10**
Module : 5	
Plane kinematics and kinetics of rigid bodies including work-energy and impulse-momentum principles; single degree of freedom rigid body systems.	**10**
Total	**48**

Text	1. H. Shames, "Engineering Mechanics: Statics and Dynamics", 4th Ed., PHI, 2002. 2. F. P. Beer and E. R. Johnston, "Vector Mechanics for Engineers, Vol I – Statics", Vol II -Dynamics, 3rd Ed., Tata McGraw Hill, 2000.
Reference	1. S. Timoshenko, D.H. Young, J.V. Rao and S. Pat, "Engineering Mechanics", Paperback –1 Jul 2017. 2. 1. J. L. Meriam and L. G. Kraige, "Engineering Mechanics, Vol I - Statics, Vol II –Dynamics", 5th Ed., John Wiley, 2002.4).

Course Code	Course name	L	T	P	C	Year	Semester
MA201	Engineering Mathematics III	3	1	0	4	2nd	3rd
Topic	**Contents**						**No. of Lectures**
Module-I	Complex numbers and elementary properties. Complex functions - limits, continuity and differentiation. Cauchy-Riemann equations. Analytic and harmonic functions.						**08**
Module-II	Elementary functions. Anti-derivatives and path (contour) integrals. Cauchy-Goursat Theorem. Cauchy's integral formula, Morera's Theorem. Liouville's Theorem, Fundamental Theorem of Algebra and Maximum Modulus Principle. Taylor series. Power series. Singularities and Laurent series.						**09**
Module-III	Cauchy's Residue Theorem and applications. Mobius transformations; Partial Differential Equations: First order PDEs; solutions of linear and nonlinear first order PDEs; classification of second-order PDEs.						**08**
Module-IV	Method of characteristics Iin PDE; boundary and initial value problems (Dirichlet and Neumann type) involving wave equation, heat conduction equation, Laplace's equations and solutions by method of separation of variables; initial boundary value problems.						**08**
Module-V	Solution of PDE by Laplace transform; Fourier series, Fourier integrals; Fourier transforms, sine and cosine transforms; solution of PDE by Fourier transform.						**10**
						Total	**43**
Text	1. B S Grewal, J S Grewal, J K Dhanoa, *Higher Engineering Mathematics*, Khanna Publishers, 44th edition, 2017. 2. E. Kreyszig, H. Kreyszig, E. J. Norminton, *Advanced Engineering Mathematics*, 10th, Wiley India Pvt. Ltd., 2017						
Reference	1. Ian N Sneddon, *Elements of Partial Differential Equations*, Dover Publications; 2006. 2. John H Mathews, Russell W Howell, *Complex Ananlysis for Mathematics and Engineering*, Jones and Bartlett India Pvt.Ltd, 6th edition, 2011. 3. James Ward Brown, Ruel V Churchill, *Complex Variables and Applications*, Tata McGraw Hill Education, *8th edition, 2016.*						

Course Code	Course name	L	T	P	C	Year	Semester
ME201	Solid Mechanics	3	0	2	4	2nd	3

Course objective:

1) To understand the basic concepts of the stresses and strains for different materials and strength of structural elements.
2) To know the development of internal forces and resistance mechanism for one dimensional and two dimensional structural elements.
3) To analyse and understand different internal forces and stresses induced due to representative loads on structural elements.
4) To analyse and understand principal stresses due to the combination of two dimensional stresses on an element and failure mechanisms in materials.
5) To evaluate the behavior of torsional members, columns and struts.

Topic	Contents	No. of Lectures
Module 1		
	Introduction, Definition and concept and of stress and strain. Hooke's law, Stress-Strain diagrams for ferrous and non-ferrous materials, factor of safety, Elongation of tapering bars of circular and rectangular cross sections, Elongation due to self-weight.Compound bars, Temperature stresses, Compound section subjected to temperature stresses, state of simple shear, Elastic constants and their relationship	**8**
Module 2		
	Stress at a point, analysis of deformation and definition of strain components, principal stresses and strains, Mohr's circle representation. Constitutive relations.	**8**
Module 3		

Material properties for isotropic materials and their relations, 3d stress – strain, Theories of failures for isotropic materials.		**8**
Module 4		
Shear Force and Bending Moment diagrams. Axially loaded members. Stresses due to bending: pure Bending, transverse shear.		**8**
Module 5		
Torsion of circular shafts, Combined stresses due to bending, torsion and axially loading.Deflections due to bending, Strain energy due to axial, torsion, bending and transverse shear. Castigliano's theorems. Thin cylinders and spherical vessels, columns.		**8**
	Total	**40**
Text	1) E. P. Popov, "Engineering Mechanics of Solids", Prentice Hall, 1998. 2) F. P. Beer, E. R. Johnston (Jr.) and J.T. DeWolf, "Mechanics of Materials", Tata McGraw Hill, 2005.	
Reference	1) S. H. Crandall, N. C. Dahl, and T. J. Lardner, "An Introduction to The Mechanics of Solids", 2nd Ed., Tata McGraw Hill, 2008. 2) S. P. Timoshenko, "Strength of Materials, Vols. 1 & 2", CBS Publishers, 1986.	

Course Code	**Course name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
HS201	Management Concepts and Technology	2	0	0	2	2nd	3rd
Topic	**Contents**						**No. of Lectures**
Module-I	Principles of Management: Concept of Management, Functions of Management, Planning and its Nature &Organising, Designing organizational Structure, Authority relationships,						**04**
Module-II	Delegation of Authority. Staffing: Motivation and its Theory, Leadership Communication. Directing, Controlling & its techniques. Coordinating; Principles of Economic: Microeconomics: Concept of consumption, production, exchange, distribution.						**05**
Module-III	Demand analysis: Concept, kind of demand, change in demand, law of demand; Utility analysis: Marginal, total, consumer surplus, consumer equilibrium; Production analysis: Law of supply, different factors of production, law of returns, economies of scale.						**06**
Module-IV	Cost analysis: Cost concept, importance of cost behaviour, cost classification; Pricing analysis: Different kinds of markets, pricing & equilibrium in different markets - perfect, imperfect, monopoly.						**05**
Module-V	Income distribution: Briefing them about rent, wages, interest and profit. The international economics: Changing scenario, globalization, structural adjustment programme, stabilization policy, the multinational corporation. IBRD, IMF, GATT, WTO, ITO, IDA, IFC, MIGA.						**05**
	Total						**25**
Text	1. Business Organisation& Management - C.R Basu. 2. Essentials of Management - Harold Koontz, HeingWerhrich. 3. An introduction to Positive Economics; Lipsey. 4. Modern Microeconomics; A. Koutsoyiannis. 5. Managerial Economics - Analysis, Problems and Cases; P.L. Mehta. 6. Business Economics; ManabAdhikary.						

Course Code	Course name	L	T	P	C	Year	Semester
CS201	Object Oriented Programming	3	0	0	3	2nd	3rd

Course objective: The course is designed to provide students with complete knowledge of Object Oriented. Programming through C++ and to enhance the programming skills of the students by giving practical assignments to be done in labs. The course also aims to provide students with requisite knowledge about Object Oriented Programming through C++ so that they make their own Applications/Projects using C++.

Topic	Contents	No. of Lectures
Module-I	Principles of OOPs, Basics of C++, Functions in c++ : Basic Concepts of OOP, Benefits of OOP, OOP Languages, Applications of OOP. C++ program basics, data types, operators in c++, scope resolution, type cast operators, operator overloading, operator precedence. Main function, function prototyping, call by reference, inline functions, default arguments, constant arguments, function overloading, friend and virtual functions, maths library functions.	**08**
Module-II	Classes, objects, constructors and destructors – C structures revisited, specifying a class, defining a member function, private member functions, memory allocation for objects, static data members and member functions, array of objects, objects as function arguments, friendly functions, returning objects, pointers to members, constructors, Parametrized constructors, Multiple constructors, Copy constructor, Destructors.	**08**
Module-III	Operator overloading, inheritance, virtual functions and polymorphism – Overloading unary operators, overloading binary operators, rules for overloading operators, type conversions. Derived classes, single inheritance, multilevel inheritance, multiple inheritance, hierarchical inheritance, hybrid inheritance, virtual base classes, abstract classes, nesting of classes. Pointers, pointer to objects, this pointer, pointer to derived classes, virtual functions, pure virtual functions.	**09**
Module-IV	Console I/O operations, working with files and templates – C++ streams and stream classes, unformatted I/O operations, formatted console I/O operations, managing output with manipulators. Classes for file stream operations, opening/closing of file, file pointers and their manipulation, error handling during file operation, command line arguments. Class templates, class template with multiple parameters, function templates, overloading template functions, member function templates, non-type template arguments.	**09**
Module-V	Exception handling and Standard template library – Basics of exception handling, exception handling mechanism, throwing mechanism, catching mechanism, rethrowing exception, specifying exception. Components of STL, Containers, Algorithms, Iterators, Application of Container classes, Functions objects.	**08**
	Total	**42**
Text	1. E. Balagurusamy, *Object Oriented Programming with C++*, Tata McGraw Hill. 2. Herbert Schildt, *C++: The Complete Reference*, Osborne, 1991.	
Reference	1. Bjarne Stroustrup, *1. The C++ programming language*, Pearson Education, 2017.	

Course Code	Course name	L	T	P	C	Year	Semester
ME202	Thermodynamics	3	0	0	3	2nd	3rd

Course objective:

1. To make familiar with thermodynamic systems and different process.
2. To know the basic laws of thermodynamics, zeroth law, first law, second law
3. Identify different types of properties ex. extensive and intensive property.
4. To develop understanding of entropy

Contents	No. of Lectures
Module : 1	

Thermodynamic systems, States, processes, Zeroth law, work and heat,	**6**
Module : 2	
Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, Extension of the First law to control volume; steady flow energy equation(SFEE), important applications.limitations of first law of thermodynamics, Thermal reservoir, Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles.	**8**
Module : 3	
Definitions of a reversible process, reversible heat engine, importance and superiority of a reversible heat engine and irreversible processes; factors that make a process irreversible, reversible heat engines. Unresisted expansion, remarks on Carnot's engine, internal and external reversibility, Clasius inequality, Statement- proof, Entropy- definition, a property, change of entropy, entropy as a quantitative test for irreversibility, principle of increase in entropy	**8**
Module : 4	
Introduction, Availability (Exergy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, irreversibility, second law efficiency	**8**
Module : 5	
P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use. Properties of mixtures of ideal gases, Thermodynamic cycles - Otto, Diesel, dual and Joule	**8**
Total	**38**
Text	1. R. E. Sonntag, C. Borgnakke and G. J. V. Wylen, "Fundamentals of Thermodynamics", 6th Ed., John Wiley, 2003. 2. P. K. Nag, "Engineering Thermodynamics", 5th Ed., Tata McGraw Hill Pub. 2013.
Reference	1. Y. A. Cengel and M. A. Boles, "Thermodynamics, An Engineering Approach", 4th Ed., Tata McGraw Hill, 2003. 2. G. F. C. Rogers and Y. R. Mayhew, "Engineering Thermodynamics Work and Heat Transfer", 4th Ed., Pearson 2003.

Course Code	Course name	L	T	P	C	Year	Semester
ME203	Electrical Machine	3	0	2	4	2nd	3

Course objective:

The aim is to deep exposition of the theory of electromechanical devices with specific emphasis on the theory of electric machines. The students would be able to understand and implement fundamentals of rotating electrical machines.

Contents	No. of Lectures
Module : 1	
Gauss's law for electric fields and magnetic fields, Faraday's law, The Ampere–Maxwell law, Magnetic Circuits, Magnetic Materials and their properties, Magnetically induced EMF and Force, AC Operation of Magnetic Circuits, Hysteresis and Eddy-Current Losses, Permanent Magnets, Application of Permanent Magnet Materials, Energy in Magnetic System, Field Energy and Mechanical Electromechanical Systems Force, Multiply-Excited Magnetic Field Systems, Forces/Torques in Systems with Permanent Magnets, Energy Conversion via Electric Field, Dynamical Equations of	**9**
Module : 2	
Introduction, Transformation Construction and Practical Considerations, Transformer on No-Load, Ideal Transformer, Real Transformer and Equivalent Circuit, Transformer Losses, Transformer testing, The per unit system, Efficiency and voltage regulation, Three phase transformers, Phase Conversion, Voltage and Current Transformers, Transformer as a Magnetically Coupled Circuit	**8**
Module : 3	
Elementary Machines, Generated EMF, MMF of distributed 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 Winding, DC winding, Fractional kilowatt motors.	**8**
Module : 4	
DC Machines: Introduction, EMF and Torque, Circuit Model, Armature reaction, Commutation, Methods of Excitation, Magnetisation Characteristics, Self-Excitation, Characteristics of DC Motor/Generator, Starting of DC motors, Speed control of DC motor, DC Machine dynamics, Permanent Magnet DC motors	**8**
Module : 5	
Induction Machine: Introduction, Flux and MMF Waves in Induction Motor – Principle of Operation, Development of Circuit Model, Power across air gap, Torque and Power Output, Tests to determine circuit model parameters, Starting, Cogging and Crawling, Classes of squirrel cage motors,	**8**
Total	**41**

Text	1)A Fitzgerald," Electric Machinery", , McGrawHill, 2017. 2)D. P. Kothari and I. J. Nagrath, "Electric Machines", McGrawHill, 2013.
Reference	1) S. Chapman, " Electric Machinery Fundamentals", McGrawHill, 2017. 2) D. Fleish, "A Student's Guide to Maxwell's Equations", 2008.

Course Code	Course name	L	T	P	C	Year	Semester
EC204	Analog Electronics	3	0	0	3	2nd	3rd

Course objective: The objective of this course is to provide an introduction to Amplifiers using transistors. More particularly,

1. To give the idea about fundamental properties of semiconductors.
2. To prepare students to perform the analysis of any Analog electronics circuit.
3. To empower students to understand the design and working of BJT / FET amplifiers, oscillators and Operational Amplifier.

Topic	Contents	No. of Lectures
Module-I	BJT Amplifiers: Transistor Configuration analysis, Biasing circuit techniques, Locating the Q-points, Fixed bias or Base bias, Stability of the operating point, Stability factor, AC load line, Emitter /feedback bias, Collector feedback bias, Small signal CE amplifier, CC amplifier, h-parameters, Hybrid π model analysis, Frequency response, Feedback amplifiers: negative and positive feedback. Topologies of the feedback amplifiers, Effect of feedback on gain, Input and output impedances, Effect of positive feedback	**10**
Module-II	FET Amplifiers: Operation, Trans-conductance curve, Biasing of FET, Self-Bias, Voltage divider bias, Current source bias. Compound configuration: Darlington circuit, Cascade Amplifier, Types of Coupling: RC Coupling, Impedance Coupling, Transformer Coupling, Direct Coupling	**08**
Module-III	Transistorized Audio Power Amplifiers, Difference between Voltage and Power amplifier, Performance quantities, Class A, Class B, Class C power amplifiers. Thermal Runway, Heat Sink, Stages of practical power amplifier. Oscillators: Harmonic Oscillators, RC Phase shift Oscillators, Transistor Phase Shift Oscillator, Colpitts Oscillators and Crystal Oscillator	**06**
Module-IV	IC Op-Amps and its ideal characteristics, Basic analog circuit using Op-Amps, Miscellaneous circuits and techniques: Capacitance multiplier, Inductance simulator, Non-inverting and Inverting Integrator and Differentiator, Differential amplifiers, Current mirrors, Parameters of Op-Amp, Open loop and Closed loop Op-amp configuration, Voltage Series and Voltage Shunt feedback	**08**
Module-V	Filters: first and second order low pass and high pass filters, Comparators, Schmitt trigger circuit, Oscillator, Triangular wave generator, Voltage regulator, Emitter follower regulator, current source, Sample and hold circuits, Log and Antilog amplifiers.	**08**
	Total	**42**
Text	1. B. Razavi, *Design of Analog CMOS Integrated Circuits*, Tata McGraw-Hill, 2nd edition, 2017. 2. A. S. Sedra, K. C. Smith and A. N. Chandorkar, *Microelectronics circuits*, Oxford university Press India, International Version 7th edition, 2017.	
Reference	1. R. J. Baker, H W Li, D. E. Boyce, *CMOS Circuit design, Layout and Simulation*, John Wiley & Sons, 2nd edition, 2004.	

Course Code	Course name	L	T	P	C	Year	Semester
MA202	Probability and Statistics	3	1	0	4	2nd	4th
Topic	**Contents**						**No. of Lectures**
Module-I	Basic Probability: Sample Space and Events. The notion and axiom of Probability, equally likely events, independent events; Conditional Probability, Expectations; Random Variables: Discrete and Continuous Probability Distributions. Moments, Moment Generating Functions.						**08**

Module-II	Distributions:Binomial-Poisson-Geometric-Uniform-Normal-exponential-Gamma; Two Dimensional Random Variables: Joint Distribution, Marguinal and Conditional Distribution, Covariance, Correlation Coefficient, Linear Regression.	**10**
Module-III	Transformation of random variables, Sampling Distributions: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Chi-square, t- and F distributions. Descriptive Statistics: Graphical representation, measures of locations and variability.	**09**
Module-IV	Estimation: Unbiasedness, Consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions.	**07**
Module-V	Testing of hypotheses: Null and alternative hypotheses, the critical and acceptance regions, two types of error, power of the test, the most powerful test and Neyman-Pearson Fundamental Lemma, tests for one sample and two sample problems for normal populations, tests for proportions, Chi-square goodness of fit test and its applications.	**09**
	Total	**43**
Text	1. P G Hoel, S C Port, C J Stone, *Introduction to Probability Theory*, Universal Book Stall; 2000. 2. J. Medhi, *Stochastic Processes*, New Age International, 4th edition, 2017.	
Reference	1. R. D. Yates and D. J. Goodman, *Probability and Stochastic Processes*, Wiley India, 2nd edition, 2012.	

Course Code	**Course name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
ME204	Design of Machine Elements	3	0	0	3	2nd	4th

Course objective:

1. To understand procedure of machine design and develop an ability to apply it for simple component design by using design data hand book.
2. To understand the different theories of failure and develop an ability to apply its knowledge for design of mechanical component and determine the resisting areas against failure.
3. To determine forces on transmission shaft and design of transmission shaft.
4. To determine the endurance strength and design of components subjected to fluctuating loads.
5. To determine the forces in welds and riveted joints and formulate design solution for size of weld and size of rivet.
6. To determine forces on power screw and bolted joints and formulate design solution for size of power screw and size of bolt.

Contents	**No. of Lectures**
Module : 1	
Introduction to the design process, factors influencing machine design, selection of materials based on mechanical properties - Preferred numbers, fits and tolerances - Direct, Bending and torsional stress equations - Impact and shock loading - calculation of principle stresses for various load combinations, eccentric loading - curved beams - crane hook and 'C' frame- Factor of safety - theories of failure - Design based on strength and stiffness - stress concentration - Design for variable loading	**8**
Module : 2	
Design of solid and hollow shafts based on strength, rigidity and critical speed - Keys, keyways and splines - Rigid and flexible couplings	**8**
Module : 3	

Threaded fastners - Bolted joints including eccentric loading, Knuckle joints, Cotter joints - Welded joints, riveted joints for structures - theory of bonded joints, Flat belt drive, V-belt drive, chain drive, rope drive, spur gear, helical gear, bevel gear, worn gear	**8**
Module : 4	
Various types of springs, optimization of helical springs, Flywheels considering stresses in rims and arms for engines and punching machines- Connecting Rods and crank shafts	**7**
Module : 5	
Sliding contact and rolling contact bearings, Hydrodynamic journal bearings, Sommerfeld Number, Selection of Rolling Contact bearings	**8**
Total	**39**

Text	1. V. B. Bhandari, "Design of Machine Elements", 2nd Ed., Tata Mcgraw Hill, 2007. 2. Design Data Book of Engineers, Compiled by Faculty of Mechanical Engineering, PSG College of Technology, Publisher KalaikathirAchchagam, Coimbataore, 2009.
Reference	1. J. E. Shigley, "Mechanical Engineering Design", McGraw Hill, 1989. 2. A. H. Burr and J. B. Cheatham, "Mechanical Analysis and Design", 2nd Ed., Prentice Hall, 1997.

Course Code	**Course name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
ME205	**Kinematics of Machinery**	3	0	0	3	2nd	4th

Course objective:

1. To understand the basic components and mechanism of linkages in the assembly of a system /machine.
2. To understand the principles of mechanism and use in the assembly with respect to the displacement, velocity, and acceleration at any point in a link.
3. To understand the motion of a specified set of linkages,
4. To design cam mechanisms for specified output motions.
5. To understand the concepts of gears and kinematics of gear trains.

Contents	**No. of Lectures**
Module 1	
BASICS OF MECHANISMS: Introduction, mechanisms and machines: types of constrained motion, rigid and resistant bodies, link, types of links, kinematic pairs, types of joints, degree of freedom, classification of kinematics pairs, kinematic of chain, Elements of kinematic chain, linkage, mechanism and structure, mechanism and their inversions: Four bar, Slider crank, Double slider crank Mobility of mechanism. **Miscellaneous mechanisms:** Straight line motion mechanisms: Peaucellier's mechanism, Hart mechanism, Sccot-Russel mechanism, Grass-Hopper mechanism Tchebicheff mechanism, and	**8**

Robert\'s mechanism, Intermittent Motion mechanisms:Genevawheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, condition forcorrect steering, Ackerman steering gear mechanism.	
Module 2	
KINEMATICS OF LINKAGE: Displacement, velocity and acceleration analysis of planar mechanisms by graphical and analytical: Four bar mechanism, slider crank mechanism, crank and slotted-liver mechanism, Coriolis acceleration components.	**8**
Module 3	
Velocity Analysis by Instantaneous Center Method: Definition, Kennedy\'s theorem,Determination of linear and angular velocity using instantaneous center method. Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism. **SYNTHESIS OF MECHANISM**: Introduction, Dimensional synthesis for motion; function and path generation	**8**
Module 4	
Cam: Definition, types of cam, types of followers, displacement, velocity and acceleration curves for uniform velocity, Simple Harmonic Motion, Uniform Acceleration Retradation, Cycloidalmotion. Under cutting, Cam profiles: disc cam with reciprocating / oscillating follower having knife-edge, rollerand flat-face follower inline and offset.	**8**
Module 5	
GEARS AND GEAR TRAINS: Gears (spur, helical, bevel and worm) Gear trains: simple, compound and epicyclic gearing	**8**
Total	**40**

Text	1. K. J, Waldron and G. L. Kinzel, "Kinematics, Dynamics and Design of Machinery", 2nd Ed., Wiley Student Edition, 2004. 2. S. S. Rattan, "Theory of Machines", 4th Edition, Tata McGraw-Hill, 2014.
Reference	1. J. J. Uicker (Jr), G. R. Pennock and J. E. Shigley, "Theory of Machines and Mechanisms", 3rd ed., Oxford International Student Edition. 2. R. L. Norton, "Kinematics and Dynamics of Machinery", Tata Mcgraw Hill, 2009.

Course Code	**Course name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
ME206	Manufacturing Science	3	0	2	4	2nd	4

Course objective:

1. Learning of various methods of manufacturing process helps to fabricate parts, device or components during project or any other research works of the students mainly Electronics and Mechatronics engineering.
2. To impart knowledge on selection of suitable manufacturing process for the typical component.

Contents	**No. of Lectures**
Module : 1	

Introduction to manufacturing processes ; Patterns: Types and various pattern materials. Various moulding process and parameters, Various casting methods, viz., sand casting, investment casting, pressure die casting, centrifugal casting, continuous casting, Casting defects ; brazing, soldering, welding; Solid state welding methods; resistance welding; arc welding; submerged arc welding; friction stir welding, inert gas welding; Welding defects	**7**
Module : 2	
Various metal forming techniques, viz., forging, rolling, extrusion, wire drawing, sheet metal working, spinning, swaging, thread rolling; Super plastic deformation; Metal forming defects ; Powder metallurgy and its applications	**7**
Module : 3	
Mechanics, tools (material, temperature, wear, and life considerations), geometry and chip formation; surface finish and machinability ; optimization; Machine tool: Generation and machining principles; Setting and Operations on machines: lathe, milling (including indexing), shaping, slotting, planing, drilling, boring, broaching, grinding (cylindrical, surface, centreless), thread rolling and gear cutting machines	**7**
Module : 4	
Jigs and fixtures: Purposes of jigs and fixtures principles of location and clamping ; Introduction and Familiar with M-codes and G-codes ; Introduction, 3D printer	**7**
Module : 5	
Ultrasonic machining, Water Jet Machining, Abrasive Jet Machining, Electric Discharge Machining, Electron Beam Machining, Laser Beam Machining, Ion Beam Machining, Electro chemical Machining, etc. Process, advantages, applications	**8**
Total	**36**
Text	1. A. Ghosh and A. K. Mallik, "Manufacturing Science", Wiley Eastern, 1986. 2. P. N. Rao, "Manufacturing Technology: Vol. I and Vol. II", Tata McGraw Hill.
Reference	1) J. S. Campbell, "Principles of Manufacturing Materials and Processes", Tata McGraw Hill, 1995. 2) S. Kalpakjian and S. R. Schmid, "Manufacturing Processes for Engineering Materials", Pearson education, 2009.

Course Code	Course name	L	T	P	C	Year	Semester
ME207	**Fluid Mechanics**	3	0	0	3	2nd	4th

Course objective

1) To develop understanding of properties of Newtonian fluid.

2) To develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.
3) To imbibe basic laws and equations used for analysis of static and dynamic fluids.
4) To inculcate the importance of fluid flow measurement and its applications in Industries.
5) To determine the losses in a flow system, flow through pipes, boundary layer flow and flow past immersed bodies.

	Contents	No. of Lectures
Module-I		
	Introduction, properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapourpressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc.,pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, Absolute, gauge, atmospheric and vacuum pressures pressure measurement by simple, differential manometers and mechanical gauges. Total pressure and center of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid. Buoyancy, center of buoyancy, meta center and meta centric height its application in shipping, stability of floating bodies.	**8**
Module-2		
	Types of Flow-steady, unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational, stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates. Rotation, vorticity and circulation, Laplace equation in velocity potential and Poisson equation in stream function, flow net. Momentum equation, Impacts of jets- force on fixed and moving vanes.Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venture meter, orifice meter, rectangular and triangular notch, pitot tube, orifices etc.	**8**
Module-3		
	Reynold's Number, Entrance flow and Developed flow, Navier-Stokes Equation, Laminar flow between parallel plates, Poiseuille equation – velocity profile, Couette flow, fully developed laminar flow in circular pipes, Hagen - Poiseuille equation. Energy consideration in pipe flow, Loss of Pressure Head due to Fluid Friction, Darcy Weishach formula, major and minor losses in pipes, Commercial pipe, Colebrook equation, Moody equation/ diagram. Pipes in series, parallel, equivalent pipe.	**8**
Module-4		
	Development of boundary layer, Prandtl's boundary layer equations, Blasius solution, laminar layer over a flat plate, boundary layer separation and its control. Basic concept of Lift and Drag, Types of drag, Co-efficient of drag and lift, streamline body and bluff body, flow around circular bodies and airfoils, Lift and drag on airfoil.	**8**
Module-5		
	Dimensional analysis: Need for dimensional analysis, Dimensions and units, Dimensional Homogeneity and dimensionless ratios, methods of dimensional analysis, Rayleigh's method, Buckingham Pi theorem, Similitude and Model studies.	**6**
	Total	**38**
Text	1) I. H. Shames, "Mechanics of fluids", McGraw Hill Book Co., 1986. 2) F. M. White, "Fluid Mechanics", 6th Ed., Tata McGraw Hill, New Delhi, 2009.	

Reference	1) Y. A. Cengel and J. M. Cimbala, "Fluid Mechanics, Fundamentals and Applications", 7th Ed. Tata McGraw Hill, New Delhi, 2009. 2) S. K. Som and G. Biswas, "Fluid Mechanics and fluid Machines", 2nd Ed., Tata McGraw Hill, New Delhi, 2005.

Course Code	Course name	L	T	P	C	Year	Semester
ME212	**Simulation Lab**	0	0	3	2	2nd	4th

Course objective:

The course is intended to expose the student to the various simulation tools (Adams, Ansys, Maxwell) so that they would be able to,

1) Design and simulate a mechanism
2) Perform structural analysis
3) Design and simulate electromagnetic systems

Topic	Contents	No. of Lab
Mechanism simulation	To study and make the various types of Links, Pairs, Chain and Mechanism in MSC Adams.	**1**
	To study and make inversion of Four Bar Mechanism, Single Slider Crank Chain Mechanism and Double Slider Crank Chain Mechanism in MSC Adams.	**1**
	To plot velocity diagram for Slider Crank Mechanism in MSC Adams	**1**
	To setup the various types of Cam and Follower arrangement and plot follower displacement Vs cam rotation graph for various cam follower arrangement in MSC Adams.	**1**
Structural Analysis	Stress analysis of, 1. Bars of constant cross section area, tapered cross section area and stepped bar 2. Beams –Simply supported, cantilever, beams with point load, UDL, beams with varyingload 3. A rectangular plate with a circular hole	**5**
Electromagnetic Analysis	Modelling of a horseshoe-shaped permanent magnet and calculation of force acting on a nearby iron	**1**
	Modelling of a E-core transformer	**1**
	Voltage Induced in a Coil by a Moving Magnet	**1**
	Total	**12**

Course Code	Course name	L	T	P	C	Year	Semester
EC301	Digital Signal Processing	3	0	0	3	3rd	5th

Course objective: The main objectives of the course are: to identify the signals and systems, apply the principles of discrete-time signal analysis to perform various signal operations, apply the principles of z-transforms to finite difference equations, apply the principles of Fourier transform analysis to describe the frequency characteristics of discrete-time signals and systems, apply the principles of signal analysis to filtering and use computer programming tools to process and visualize signals.

Topic	Contents	No. of Lectures
Module-1	Review of discrete time signals, systems and transforms: Discrete time signals, systems and their classification; Analysis of discrete time LTI systems: impulse response, difference equation, frequency response, transfer function, DTFT, DTFS and Z-transform.	**08**
Module-2	Ideal filter characteristics, low-pass, high-pass, band-pass and band-stop filters, Paley-Wiener criterion, digital resonators, notch filters, comb filters, Butterworth filter, chebyshev filter**,** inverse systems, minimum phase, maximum phase and mixed phase systems.	**08**
Module-3	Signal flow graph representation, basic structures for FIR and IIR systems (direct, parallel, cascade and polyphase forms), transposition theorem, ladder and lattice structures; Design of FIR filters using windows, frequency sampling, Remez algorithm and least mean square error methods; Design of IIR filters using impulse invariance, bilinear transformation and frequency transformations.	**09**
Module-4	Computational problem, DFT relations, DFT properties, fast Fourier transform (FFT) algorithms (radix-2, decimation-in-time, decimation-in-frequency), Goertzel algorithm, linear convolution using DFT.	**08**
Module-5	Finite word-length effects in digital filters: Fixed and floating point representation of numbers, quantization noise in signal representations, finite word-length effects in coefficient representation, round-off noise, SQNR computation and limit cycle; Introduction to multi-rate signal processing: Decimation, interpolation, poly-phase decomposition.	**09**
	Total	**42**
Text	1. S. K. Mitra, Digital Signal Processing: *A Computer-Based Approach*, Tata McGraw Hill, 2nd edition, 2001. 2. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, PHI, 4th edition, 2007.	
Reference	1. A. V. Oppenheim and R. W. Shafer, *Discrete-Time Signal Processing*; PHI, 2nd edition, 2004.	

Course Code	Course name	L	T	P	C	Year	Semester
EC302	Control Systems	3	1	0	4	3rd	5th

Course objective: To provide the basic skills required to understand, develop, and design various engineering applications involving electromagnetic fields. To lay the foundations of electromagnetism and its practice in modern communications such as wireless, guided wave principles such as fiber optics and electronic electromagnetic structures.

Topic	Contents	No. of Lectures
Module-1	Basic Concepts of Control Systems: Open loop and closed loop systems, Derivation of Transfer functions, Signal flow Graphs, Mason's Gain Formula; Feedback characteristics of Control Systems; Time response of first order and Second order systems, Steady State Errors and Static Error Constants of systems.	**09**
Module-2	Routh-Hurwitz stability criterion, Application of the Routh stability criterion to linear feedback system, Relative stability by shifting the origin in s-plane; Root locus concepts, Root contours, Systems with transportation lag. Effect of adding open loop poles and zeros on Root locus; Frequency domain specifications, correlation between Time and Frequency Response with respect to second order system, Polar plots, Bode plot, Determination of Gain Margin and Phase Margin from Bode plot	**08**
Module-3	Stability in frequency domain: Principle of argument, Nyquist stability criterion, Application of Nyquist stability criterion for linear feedback system. Constant M-circles, Constant N-Circles, Nichol's chart; Controllers: Concept of Proportional, Derivative and Integral Control actions, P, PD, PI, PID controllers. Zeigler-Nichols method of tuning PID controllers	**08**

Module-4	Mapping between the S-Plane and the Z-Plane, Primary strips and Complementary Strips, Constant frequency loci, Constant damping ratio loci, Stability Analysis of closed loop systems in the Z-Plane. Jury stability test, Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion.	**08**
Module-5	Transient and steady State Response Analysis, Design based on the frequency response method, Bilinear Transformation and Design procedure in the w-plane, Lead, Lag and Lead-Lag compensators and digital PI, PD, and PID controllers.	**09**
	Total	**42**
Text	1. I. G. Nagarath, M. Gopal, *Control Systems*, Tata McGraw Hill Education, 4th edition, 2012. 2. M. Gopal, Digital Control and State Variables Methods, Tata McGraw Hill Education, 2nd edition, 2003.	
Reference	1. B. C. Kuo, *Automatic Control Systems*, Tata McGraw-Hill, 10th edition, 2017. 2. K. Ogata, *Modern Control Engineering*, Pearson Education India, 5th edition, 2015.	

Course Code	**Course name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
ME301	**Dynamics of Machinery**	3	0	2	4	3rd	6th

Course objective:

1. To understand the force-motion relationship on mechanism when subjected by external forces.
2. To understand the importance of balancing on rotating and reciprocating masses.
3. To understand the mechanism of controlling of stability by gyroscope.
4. To understand the importance of governor on controlling of fuels on vehicles.
5. To understand the avoiding of undesirable vibration from the system.

Contents	**No. of Lectures**
Module 1	
Static force analysis: Introduction, Introduction: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque, Equilibrium of four-force member, Force convention, Free-body diagrams, Superposition, Principle of virtual works, Friction in mechanisms.	**8**
Module 2	
Dynamics force analysis: D'Alembert's principle, Inertia force, inertia torque. Dynamic force analysis of four-bar mechanism and slider crank mechanism. Dynamically equivalent systems. Turning moment diagrams and flywheels. Fluctuation of Energy. Determination of size of flywheels. **BALANCING:** Static and dynamic balancing, Balancing of several masses in different planes, Balancing of rotating and reciprocating masses.	**8**
Module 3	
Gyroscope: Gyroscope and gyroscopic effects: Introduction, Angular velocity and acceleration, Gyroscopic torque (couple), Gyroscopic effect on airplane and naval ship, Stability of an automobile and a two-wheel vehicle. **Governors:** Introduction, types of governor , Watt, Porter, Proell, Hartnel, Hartung, Wilson-Hartnel, Spring-controlled gravity and Inertia governor, Controlling force ,Stability, Sensitiveness of governor, Isochronism, Effort and power of governor. **Cam dynamics**: analysis of cam and follower, jump phenomenon;	**8**
Module 4	

Vibration: Vibrations of one degree of freedom systems; Free and Force vibrations; Transverse and torsional vibrations of two and three rotor systems; critical speeds; Vibration isolation and measurements; two-degree of freedom systems; Geared system	**8**
Module 5	
Introduction to Multi-degree of Freedom System :normal mode vibration, coordinate coupling, forced harmonic vibration, vibration absorber (tuned, and centrifugal pendulum absorber), vibration damper; Properties of vibrating system, flexibility matrix, stiffness matrix, reciprocity theorem, eigenvalues and eigenvectors, orthogonal properties of eigenvectors, modal matrix, Rayleigh damping, Normal mode summation.	**8**
Total	**40**

Course Code	**Course name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
ME302	**Sensors and actuators**	3	0	0	3	3rd	5th

Course objective:

1. To provide theoretical and practical knowledge of sensor technology, features and characteristics of sensors.
2. Sensor applications in various fields.
3. To provide knowledge of the principles of operation of actuators and design specifications of actuators.

Contents	**No. of Lectures**
Module 1	
Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.	**8**
Module 2	
Motion, Proximity And Ranging Sensors: Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).	**8**
Module 3	
Force, Magnetic and Heading Sensors: Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers. **Optical, Pressure and Temperature Sensors :**Photo conductive cell, photo voltaic, Photo resistive, LDR – Fibre optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, LASER sensors, Bio & Nano sensors	**9**
Module 4	

Actuator: Hydraulic systems: flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits, Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, design of systems	**9**
Module 5	
SIGNAL CONDITIONING AND DAQ SYSTEMS: Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring	**8**
Total	**42**
Text	1. D. D. Patranabis, "Sensors and Transducers", PHI Learning Private Limited. 2. D.A.Hall, Sensors and Actuators, 1999 by CRC Press, 256 Pages, ISBN 9781861250896.
Reference	1. W. Boltan, "Mechatronics: electronic control systems in mechanical and electrical engineering", Longman, Singapore, 1999

Course Code	Course name	L	T	P	C	Year	Semester
CS303	Artificial Intelligence	3	0	2	4	3rd	5th

Course Objective: The objective of the course is to present an overview of artificial intelligence (AI) principles and approaches. Develop a basic understanding of the building blocks of AI as presented in terms of intelligent agents: Search, Knowledge representation, inference, logic, and learning.

Topic	Contents	No. of Lectures
Module 1	Fundamental issues in intelligent systems: History of artificial intelligence; philosophical questions; fundamental definitions; philosophical questions; modeling the world; the role of heuristics.	**2**
Module 2	Search and constraint satisfaction: Problem spaces; brute-force search; best-first search; two-player games; constraint satisfaction.	**10**
Module 3	Knowledge representation and reasoning: Review of propositional and predicate logic; resolution and theorem proving; non-monotonic inference; probabilistic reasoning; Bayes theorem.	**8**
Module 4	AI planning systems: Definition and examples of planning systems; planning as search; operator-based planning; propositional planning.	**8**
Module 5	Sequential decision making: Achieving behaviour by specifying rewards, Markov Decision Problems.	**7**
	Total	**35**

Text Books	**1.** Stuart Russell and Peter Norvig: Artifical Intelligence: A Modern Approach, Pearson; Third edition (2013). **2.** Elaine Rich, Kevin Knight and Shivashankar B Nair, Artificial Intelligence, Tata McGraw Hill, 3rd Edition 2009.
Reference Books	1. N. J. Nilsson, "Principles of Artificial Intelligence", Narosa Publishing House, 1980. 2. Clocksin & Mellish, Programming in PROLOG, Narosa Publ. House.

Course Code	Course name	L	T	P	C	Year	Semester

EC304	IoT & Embedded Systems	3	0	0	3	3rd	5th

Course objective: This main objective of this course facilitates to design, describe, validate and optimise embedded electronic systems in different industrial application areas. More particularly, the architecture of advanced processors, their instruction sets, interfacings to develop different kinds of systems.

1. To provide in depth knowledge about embedded processor, its hardware and software.
2. To explain programming concepts and embedded programming in C and assembly language
3. To explain real-time operating systems, inter-task communication and an embedded software development tool.

Topic	Contents	No. of Lectures
Module-I	An introduction to Embedded system design & modelling with unified mark-up language; 8-bit and 16- bit, von Neumann and Harvard architectures, CISC and RISC architectures; Advanced RISC Machines, Open source core (LEOX), Introduction to microcontrollers, ARM versions, ARM instruction set: assembly language, Thumb instruction set, memory organization, data operations and flow control; Input/output mechanisms, isolated and memory mapped IO; interrupts and real time operations, ARM interrupts vectors, priorities and latency; co-processors; cache memory and memory management.	**09**
Module-II	Embedded Platforms: bus protocols, system bus configuration, USB and SPI buses, DMA, ARM bus; memory devices: memory device configuration, ROM, RAM, DRAM; I/O devices: timers, counters, ADC & DAC, keyboards, displays and touch screens. Processes: multiple tasks and multiple processes; process abstraction; context switching: cooperative multitasking, pre-emptive multitasking, process and object-oriented design	**09**
Module-III	Operating Systems: operating systems and RTOS; scheduling polices; inter-process communication; Networks: distributed embedded architectures: networks abstractions, hardware and software architectures; networks for embedded systems: I2C bus, CAN bus.	**09**
Module-IV	An Introduction to Internet-of-Things, Sensing, Actuation, Basics of Networking; Communication Protocols, Sensor Networks, Machine-to-Machine Communications, Wireless medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination	**07**
Module-V	Developing IoTs: Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python; Domain specific applications of IoT: Home automation, Industry applications, Surveillance applications, Other IoT applications.	**08**
	Total	**42**
Text	1. A. N. Sloss, D. Symes, and C. Wright, *ARM system developer's guide: Designing and optimizing system software*; Elsevier, 1st edition. 2008. 2. Pethuru Raj and Anupama C. Raman, *The Internet of Things: Enabling Technologies, Platforms, and Use Cases*,CRC Press, 2017.	
Reference	1. Arshdeep Bahga and Vijay Madisetti, *Internet of Things: A Hands-on Approach*, Universities Press, 2017. 2. W. Wolf, *Computers as components: Principles of embedded computing system design*; Elsevier, 3rd edition, 2013.	

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 Conveyor belt, Automatic car washing machine, Bottle label detection and process control application.	**10**
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-I	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-II	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-III	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-IV	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-V	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 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,	**05**
	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.							
Topic							Hour
Module I	Introduction: History of machine learning, Basic concepts						3
Module II	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 III	Learning theory: Bias/variance trade-off, Union and Chernoff/Hoeffding bounds, VC dimension, Worst case (online) learning.						7
Module IV	Unsupervised learning: Clustering K-means, EM. Mixture of Gaussians, Factor analysis, PCA (Principal components analysis), ICA (Independent components analysis).						8
Module V	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.

Course Code	Course name	L	T	P	C	Year	Semester
HS401	Professional Ethics in Engineers	2	0	0	2	4th	7th

Course objective: To enable the students to create an awareness on Engineering Ethics and Human Values, to instil Moral and Social Values and Loyalty and to appreciate the rights of others.

Topic	Contents	No. of Lectures
Module-I	HUMAN VALUES: Morals, Values and Ethics, Integrity, Work ethic, Service learning, Civic virtue, Respect for others, Living peacefully, Caring, Sharing, Honesty, Courage, Valuing time, Cooperation, Commitment, Empathy, Self-confidence, Character-Spirituality, Introduction to Yoga and meditation for professional excellence and Stress management.	**05**
Module-II	ENGINEERING ETHICS: Senses of Engineering ethics, Variety of moral issues, types of inquiry- Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles, Theories of right action, Self-interest, Customs and Religion, Uses of Ethical theories.	**05**
Module-III	ENGINEERING AS SOCIAL EXPERIMENTATION: Engineering as Experimentation, Engineers as responsible experimenters, Code of ethics, A Balanced Outlook on Law	**04**
Module-IV	SAFETY, RERSPONSIBILITIES AND ETHICS: Safety and Risk, Assessment of Safety and risk, Risk Benefit Analysis and Reducing Risk, Respect for authority, Collective Bargaining, Confidentiality, Conflict of interest, Occupational crime, Professional Rights, Employee Rights, Intellectual Property Rights (IPR), Discrimination	**05**
Module-V	GLOBAL ISSUES: Multinational Corporations, Environmental Ethics, Computer ethics, Weapons Development, Engineers as managers, Consulting engineers, Engineers as Expert Witnesses and Advisors, Moral Leadership, Code of conduct, Corporate Social Responsibility	**05**
	Total	**24**
Text	1. Mike W Martin and Roland Schinzinger, *Ethics in Engineering*, Tata McGraw Hill, 2003. 2. Govindarajan M, Natarajan S, Senthil Kumar V S, *Engineering Ethics*, Prentice Hall of India, 2004.	

Course Code	Course name	L	T	P	C	Year	Semester
ME402	Robotics	3	0	0	3	4th	7th

Course objective:

1. To introduce the functional elements of Robotics.
2. To impart knowledge on the direct and inverse kinematics.
3. To introduce the manipulator differential motion and control.
4. To educate on various path planning techniques.
5. To introduce the dynamics and control of manipulators.

Contents	No. of Lectures
Module 1	

Introduction	Mathematical Modeling of Robots, Robots as Mechanical Devices, Common Kinematic Arrangements of Manipulators, Rigid Motions And Homogeneous Transformations	**9**
Module 2		
Kinematics	Kinematic Chains, Forward Kinematics: The Denavit-Hartenberg, Convention, Inverse Kinematics, Angular Velocity: The Fixed Axis Case, Skew Symmetric Matrices, Angular Velocity: The General Case, Addition of Angular Velocities, Linear Velocity of a Point Attached to a MovingFrame, Derivation of the Jacobian, Singularities	**9**
Module 3		
Dynamics of Robot Manipulators	The Euler-Lagrange Equations, General Expressions for Kinetic and PotentialEnergy, Equations of Motion, Some Common Configurations, Properties of Robot Dynamic Equations, Newton-Euler Formulation	**9**
Module 4		
Control of Robot Manipulator	PD control, Nonlinear Control, Stability, Lyapunov's Direct Method, Adaptive Control	**12**
Module 5		
Path-Planning	Configuration space, potential fields	**5**
	Total	**44**

Text	1. M.W.Spong, S. Hutchinson and M. Vidyasagar, "Robot Modeling and Control", Wiley, 2006 2. J. J. Craig, "Introduction to Robotics", Addision-Wesley,1989
Reference	1. A. Ghosal, "Robotics: Fundamental Concepts and Analysis", Oxford University Press, 2nd reprint, 2008.

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; Training of neural network; Applications of neural networks in mechanical engineering	**8**
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 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),	**8**
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,	**7**

Transformer Losses, Effects of Change in Frequency in Parameters of the Transformer, Optimum Design, Mechanical Forces		
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 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	**8**
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	4^{th}	7^{th}

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-I	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-II	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-III	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-IV	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-V	Nano-systems And Quantum Mechanics: Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Schrödinger Equation and Wave function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits	**08**
	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.

Elective-III Course Syllabus

Course Code	Course name	L	T	P	C	Year	Semester
ME42X	**Mechanical Vibrations**	3	1	0	4	4th	7th

Course objective:

1. To understand the one and multi-degree-of-freedom systems.
2. To find the natural frequency and modes of vibration.
3. To understand the use of vibration in practical problems and avoid the excessive vibration.

Contents	No. of Lectures
Module 1	
Introduction: Overview of the course, practical applications and research trends, Harmonic and periodic motions, vibration terminology **Single-DOF Free Vibrations**: Vibration model, Equation of motion-Natural Frequency, Energy method, Rayleigh method, Principle of virtual work, Damping models.	**8**
Module 2	
Single-DOF Free Vibrations: Viscously damped free vibration, Special cases: oscillatory, non-oscillatory and critically damped motions. Logarithmic decrement, Experimental determination of damping coefficient. **Single-DOF Forced Vibrations:** Forced harmonic vibration, Magnification factor, Rotor unbalance, Transmissibility, Vibration Isolation, Equivalent viscous damping, Sharpness of resonance.	**8**
Module 3	
Two-DOF Free Vibrations: Generalized and Principal coordinates, derivation of equations of motion, Lagrange's equation, Coordinate coupling, Forced Harmonic vibration **Vibration Absorber**: Tuned absorber, determination of mass ratio, Tuned and damped absorber, unturned viscous damper. **Multi-DOF:** Derivation of equations of motion, influence coefficient method, Properties of vibrating systems: flexibility and stiffness matrices, reciprocity theorem, Modal analysis : undamped, Modal analysis: damped.	**10**

Module 4	
Calculation of natural frequencies: Rayleigh method, Stodala method, Matrix iteration method, Holzer method and Dunkerley's method **Torsional vibration**: Simple systems with one or two rotor masses, Multi-DOF systems-transfer matrix method, Geared system, Branched system	**8**
Module 5	
Continuous systems : closed form solutions: Vibration of strings, Longitudinal and torsional vibration of rods, Transverse vibration of beams: equations of motion and boundary conditions, Transverse vibration of beams: natural frequencies and mode shapes Continuous systems : Approximate form solutions: Rayleigh's energy method, Rayleigh-Ritz method, Assumed modes and Galerkin's method	**8**
Total	**42**

Text	1. L. Meirovitch, "Elements of Vibration Analysis", McGraw Hill, Second edition, 1986. 2. S. S. Rao, "Mechanical Vibrations", 5th Ed., Prentice Hall International, 2011.
Reference	1. L. Meirovitch, "Principles & Techniques of Vibrations", Prentice Hall International (PHIPE), New Jersey, 1997. 2. W. T. Thomson, Theory of Vibration with Applications, CBS Publ., 1990.

Course Code	**Course name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
ME42X	**Computer Integrated Manufacturing**	3	1	0	4	4th	7th

Course objective:

1. Students will employ engineering and scientific concepts in the solution of engineering design problems.
2. Students will develop problem-solving skills and apply their knowledge of research and design to create solutions to various challenges.

Contents	**No. of Lectures**
Module : 1	
Introduction to CAD and CAM, Manufacturing Planning and control, CIM concepts, Computerised elements of CIM system, Types of manufacturing, Manufacturing models, Manufacturing Control	**10**
Module : 2	
Review of automation and control technologies. Material Handling technologies. Data Communication technologies. Automatic Data Acquisition technologies. Database Management technologies.	**10**
Module : 3	
Group Technology & Cellular Manufacturing Systems, Flexible Manufacturing Systems, Production flow Analysis, Transfer lines, Machine cell design and layout, Automated Assembly Systems. Quality Control Systems. Computer-Aided Process Planning. Concurrent Engineering. Production Planning and Control Systems.	**10**

Module : 4	
Levels of Automation, Lean and Agile Manufacturing.Web-based manufacturing.	**8**
Total	**38**
Text	1. M. P. Groover, "Automation production systems, and computer-integrated manufacturing", second edition, Prentice-Hall of India, New Delhi, 2001. 2. P. Radhakrishnan, S. Subramanyan and V.Raju, "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.
Reference	1. S. K. Vajpayee, " Principles of computer-integrated manufacturing", Prentice-Hall of India, New Delhi, 2005

Course Code	**Course name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
ME42X	**Introduction to Data Science**	3	1	0	4	4^{th}	7^{th}

Course Objective: The goal of this course is to provide students with an introduction to the mathematical and algorithmic foundations of data science, including machine learning, high-dimensional geometry, and analysis of large networks. The goal of this course to improve decision making power to the students through the analysis of data.

Topic	**Contents**	**No. of Lectures**
Module 1	Introduction to Data Science: Big Data and Data Science hype, Datafication, Current landscape of perspectives- Skill sets needed.	**5**
Module 2	Statistical Inference, Exploratory Data Analysis and the Data Science Process,	**7**
Module 3	Three Basic Machine Learning Algorithms- Linear Regression, K-Nearest Neighbors (k-NN), K-means. One More Machine Learning Algorithm and Usage in Applications.	**10**
Module 4	Feature Generation and Feature Selection (Extracting Meaning From Data), Recommendation Systems: Building a User-Facing Data Product,	**10**
Module 5	Mining Social-Network Graphs, Data Visualization, Data Science and Ethical Issues.	**10**
	Total	**42**
Text Books	1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline.O'Reilly. 2014. 1. John D. Kelleher, Brendan Tierney, Data Science, MIT Press, 2018.	
Reference Books	1.Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. Mining of Massive Datasets, Cambridge University Press, 2014. 2.Avrim Blum, John Hopcroft and Ravindran Kannan. Foundations of Data Science, Cambridge University Press, 2019. 3.Mohammed J. Zaki and Wagner Miera Jr. Data Mining and Analysis: Fundamental Conceptsand Algorithms, Cambridge University Press, 2014. 4.Jiawei Han, Micheline Kamber and Jian Pei. Data Mining: Concepts and Techniques, Morgan Kaufmann. 2011.	

Course Code	**Course name**	**L**	**T**	**P**	**C**	**Year**	**Semester**

ME42X	**Reinforcement Learning**	3	1	0	4	4th	7th

Course Objective: To introduce the students with basics of reinforcement learning reinforcement learning algorithms, dynamic programming and its usage in RL and state of the art applications in RL

Topic	Contents	No. of Lectures
Module 1	**Introduction to Reinforcement Learning Problem:** Reinforcement Learning, Elements of Reinforcement Learning, Limitations and Scope, An Extended Example: Tic-Tac-Toe, History of Reinforcement Learning **Multi-arm Bandits:** An n-Armed Bandit Problem, Action-Value Methods, Incremental Implementation, Tracking a Nonstationary Problem, Optimistic Initial Values, Upper-Confidence-Bound Action Selection, Gradient Bandits, Associative Search (Contextual Bandits).	**8**
Module 2	**Finite Markov Decision Processes:** The Agent–Environment Interface, Goals and Rewards, Returns, Unified Notation for Episodic and Continuing Tasks, The Markov Property, Markov Decision Processes, Value Functions, Optimal Value Functions, Optimality and Approximation. **Dynamic Programming:** Policy Evaluation, Policy Improvement, Policy Iteration, Value Iteration,	**8**
Module 3	**Dynamic Programming:** Asynchronous Dynamic Programming, Generalized Policy Iteration, Efficiency of Dynamic Programming. **Monte Carlo Methods:** Monte Carlo Prediction, Monte Carlo Estimation of Action Values, Monte Carlo Control, Monte Carlo Control without Exploring Starts, Off-policy Prediction via Importance Sampling, Incremental Implementation, Off-Policy Monte Carlo Control, Importance Sampling on Truncated Returns.	**8**
Module 4	**Temporal-Difference Learning:** TD Prediction, Advantages of TD Prediction Methods, Optimality of TD(0), Sarsa: On-Policy TD Control, Q-Learning: Off-Policy TD Control, Games.' **Policy Approximation:** Actor–Critic Methods, Eligibility Traces for Actor–Critic Methods, R-Learning and the Average-Reward Setting,	**9**
Module 5	**Policy Approximation:** Vanilla policy gradient method, REINFORCE and TROP algorithms. **State of the art applications of RL:** Latest practical application of RL: Atari, Go, robotic applications and NLP.	**8**
	Total	**41**

Text Books	1.RS Sutton Reinforcement Learning: An Introduction – Stanford University.. 2.Hands-On Reinforcement Learning with Python: Master Reinforcement and Deep Reinforcement Learning Using OpenAI Gym and TensorFlow.
Reference Books	1. Richard S. Sutton and Andrew G. BartoReinforcement Learning: An Introduction (Introduction (Adaptive Computation and Machine Learning series) Kindle Edition.

Course Code	Course name	L	T	P	C	Year	Semester
ME401	**Electro mechanics and magnetic propulsion**	3	1	0	4	4th	7th

Course objective:

The objective of the course is to provide fundamental knowledge in electro mechanics.

Contents	No. of Lectures

Module : 1	
Introduction to electromagnetics: Maxwell's Equations, Magnetic Circuits and Induction, Principles of electromechanical energy conversion;	**6**
Module : 2	
Introduction to Rotating Machines: Types of electrical machines, generalized theory of electrical machines, Reference frame theory, space vector formulation;	**8**
Module : 3	
Unbalanced Magnetic Pull: definition, cause, effect and remedies, different winding scheme to reduce unbalanced magnetic pull; Magnetic Bearings: introduction, principles of magnetic suspension, mathematical modeling, hardware components which includes power amplifiers, sensors, actuators, controllers.	**8**
Module : 4	
Self-bearing machine: Basic principles, different methods of producing controllable force, introduction to self-bearing machine and control techniques.	**6**
Module : 5	
Solution of Laplace's and Poisson's equation, coupled circuit equation and field equation; Coupled rotordynamics combining electrical dynamics and mechanical dynamics: Coupled dynamics of electrical machines, dynamics and control of rotors on magnetic bearings; System fault analysis using electromechanical devices; Magnetostriction.	**8**
Total	**36**

Text	1. S. J. Chapman, "Electric Machinery Fundamentals", McGraw Hills, Fifth Edition, 2011. 2. Gerhard Schweitzer and Eric Maslen, "Magnetic Bearings: Theory, Design and Application to Rotating Machinery", Springer, 2009.
Reference	1. Juha Pyrhonen, Tapani Jokinen and Valeria Hrabovcova, "Design of Rotating Electrical Machines", Wiley, 2nd Edition, October 2013. 2. A. Chiba, T. Fukao, M. Oshima, M. Takemoto and D. Dorrell, "Magnetic Bearings and Bearingless Drives", Elsevier, 2005.

Course Code	Course name	L	T	P	C	Year	Semester
ME401	**AUTOMOBILE ENGINEERING**	3	1	0	4	4^{th}	7^{th}

Course objective:

1. To understand the basic concept and component of automobile.
2. To understand the power generation system in automobile.
3. To understand the automobile structure and suspension system.
4. To understand the emissions and pollution control on automobile.

Contents	No. of Lectures
Module 1	

Introduction: Introduction, Basic concepts of Automobile Engineering and general configuration of an automobile, Power and Torque characteristics. Rolling, air and gradient resistance. Tractive effort. Gear Box. Gear ratio determination. **Transmission System:** Requirements. Clutches. Torque converters. Over Drive and free wheel, Universal joint.	**7**
Module 2	
Differential Gear Mechanism of Rear Axle. Automatic transmission, Steering and Front Axle. Castor Angle, wheel camber & Toe-in, Toe-out etc.. Steering geometry. Ackerman mechanism, Under steer and Over steer. **Braking system:** General requirements, Road, tyre adhesion, weight transfer, Braking ratio. Mechanical brakes, Hydraulic brakes. Vacuum and air brakes. Thermal aspects. **Chasis and Suspension System:** Loads on the frame, Strength and stiffness, Independent front & rear suspension, Perpendicular arm type, Parallel arm type, Dead axle suspension system, Live axis suspension system, Air suspension & shock absorbers.	**7**
Module 3	
Electrical System: Types of starting motors, generator & regulators, lighting system, Ignition system, Horn, Battery etc. **Fuel Supply System**: Diesel & Petrol vehicle system such as Fuel Injection Pump, Injector & Fuel Pump, Carburetor etc. MPFI.	**7**
Module 4	
Emission standards and pollution control : Indian standards for automotive vehicles-Bharat I and II, Euro-I and Euro-II norms, fuel quality standards, environmental management systems for automotive vehicles, catalytic converters, fuel additives and modern trends in automotive engine efficiency and emission control. **Maintenance system:** Preventive maintenance, break down maintenance and over hauling.	**7**
Total	**28**

Text/ Reference	1. Kripal Singh, "Automobile Engineering, Vol.1 & Vol.2.", Standard publisher and distributer 2. K. K. Jain and R. B. Asthana, "Automobile Engineering", 1st Ed., Tata Mcgraw Hill, 2017.

Open electives

Course Code	Course name	L	T	P	C	Year	Semester
XXXXX	**Quality Control**	3	1	0	4	4th	7th

Course objective:

1. To understand the philosophy and basic concepts of quality improvement in industry or organization.
2. To understand the quality control in specified limit.
3. To understand the principle of acceptance of sample.
4. To understand the defect diagnosis process of the samples.

Contents	No. of Lectures
Module 1	

Introduction: Introduction, Concept and evaluation of quality control. Measurement & Metrology, precision vs accuracy. Process capability, standardization& Interchange ability. **Inspection and Gauges:** Inspection methods. Types of Gauges. Limits Fits and Tolerances. Non-Destructive Testing& Evaluation.	**8**
Module 2	
Control charts for SQC: Statistical Quality Control (SQC). Control charts for variables suchas X, R charts and control charts for attributes such as p-chart, c-chart. Construction & use of thecontrol charts. Process capability. **Acceptance Sampling for SQC:** Introduction, Principle of acceptance sampling. Producer's and consumer's risk. Sampling plans - single, double & sequential. Sampling by attributes and variables	**8**
Module 3	
Reliability: Introduction to reliability, bath-tub curve. Life expectancy. Reliability based design. Series & Parallel System. **Defect Diagnosis and prevention**: Basic causes of failure, curve/control of failure. MTBF. Maintainability, Condition monitoring and diagnostic techniques.	**8**
Module 4	
Value Engineering: Elements of value analysis, Techniques. **TQM:** Basic Concept, Quality control , Quality Assurance and Quality Management and TotalQuality Management. Implementation of TQM . ISO 9000 and its series, Zero defect. . Taguchimethod, Six Sigma concepts.	**8**
Module 5	
Other Factors in Quality : Human Factors such as attitude and errors. Material-Quality, Qualitycircles, Quality in sales & service.	**8**
Total	**40**

Text	1. D. C. Montgomery, "Introduction to Statistical Quality Control", 6th Ed., John Wiley & Sons, Inc, 2009. 2. I. Kaoru, "Introduction to Quality Control", springer, 1989
Reference	

Course Code	**Course name**	**L**	**T**	**P**	**C**	**Year**	**Semester**
XXXXX	**Advanced Robotics**	3	1	0	4	4^{th}	7^{th}

Course objective:

1. To understand the philosophy and basic concepts of quality improvement in industry or organization.
2. To understand the quality control in specified limit.
3. To understand the principle of acceptance of sample.
4. To understand the defect diagnosis process of the samples.

Contents	**No. of Lectures**
Module 1	
CONTROL SYSTEMS AND COMPONENTS: Basic Control Systems Concepts and Models,Controllers, Control System Analysis, Robot Activation and Feedback Components,Power Transmission Systems, Robot Joint Control Design. **ROBOT END EFFECTORS:** Types, Mechanical Grippers and Other types, Tools as End Effectors, The Robot/End Effector Interface, Considerations in Gripper Selection and Design	**8**

Module 2	
MACHINE VISION: Introduction, The Sensing and Digitizing function, Image processing and Analysis,Trainig and Vision Systems, Robotic Applications.	**8**
Module 3	
ROBOT PROGRAMMING: Programming methods, Robot program as a path in space,Motion Interpolation, WAIT,SGNAL,DELAY Commands, Branching	**8**
Module 4	
ROBOT LANGUAGES : The Textual Robot languages, Generations of Robot programming languages, Robot language Structures, Constants, Variables, and other data Objects, Motion Commands, program Control and Subroutines	**10**
Module 5	
ROBOT APPLICATIONS IN MANUFCATURING: Material Transfer And Machine Loading / Unloading, An Approach for Implementing Robotics FUTURE APPLICATIONS: Characteristics of Future Robot Tasks, Future manufacturing Applications, Hazardous and Inaccessible Nonmanufacturing Environments	**8**
Total	**42**

Text

1. Mikell P. Groover , Mitchell Weiss , Roger N. Nagel , Nicholas G. Odrey Industrial Robotics: Technology, Programming, and Applications , 1stedition, McGraw-Hill International Edition, 1986
2. K.S.Fu, R.C Gonzalez, C.S.G.Lee , ROBOTICS , Control, Sensing , Vision and Intelligence , 1stedition, McGraw-Hill International Edition, 1987

Course Code	Course name	L	T	P	C	Year	Semester
XXXXX	Material Characterization Methods	3	1	0	4	4th	7th

Course objective:

1. Introduce basic techniques for materials characterization.
2. Introduce the working principles and instrumentation of main techniques.
3. Introduce the interpretation of the characterization technique outputs.
4. Observe operations of characterization equipment.

Topics	Contents	No. of Lectures
Module : 1		
Elements of Crystallography, Principles of X-ray diffraction, X-ray equipment and data analysis; associated techniques in X-ray spectroscopy, Fundamentals of elemental analysis.		**10**
Module : 2		
Optical/Electron Microscopy Techniques, Specimen preparation techniques for optical and electron microscopy in metallurgy. Elements of phase identification, grain size determination, inclusion analysis, Image analysis, etc.		**10**

Module : 3		
Electron diffraction, SEM, Failure analysis and fractography, EDAX / EPMA, data analysis. Neutron Scattering Techniques: Diffraction, inelastic scattering and reflectometry.		**10**
Module : 4		
Thermal Analysis: Principles and applications of thermal analysis; DTA, DSC, TGA, TMA, DMA, etc.		**8**
Module : 5		
Mechanical Property characterization, Principles and chartacterisation techniques related to Tensile, compressive, hardness, fatigue and fracture toughness properties. Deformation; Superplasticity		**10**
	Total	**48**

Text	1. "Materials characterization",Vol. 10, ASM hand book,1997. 2. B. D. Cullitey, "Elements of X-ray diffraction", Addison-Wesely, 1968.
Reference	1. ASTM handbook, vol. 3, 1997. 2. R. F. Speyer, "Thermal Analysis of Materials", Marcel Decker, 1994

Course Code	Course name	L	T	P	C	Year	Semester
XXXXX	Physics of Manufacturing Processes	3	1	0	4	4^{th}	7^{th}

Course objective:

1. This course gives an introduction to production methods and manufacturing technologies used in engineering.
2. The focus is given on the understanding of physical phenomena underlying the processes, the relation between materials/manufacturing processes.

Topics	Contents	No. of Lectures
Module : 1		
Stress and strain behavior of materials, plastic and tangent modulus, work hardening, plastic instability in tensile test, empirical stress-strain equations, effect of pressure, strain-rate and temperature.		**8**
Module : 2		

Analysis of stress tensor, eigenvalues, decomposition into deviatoric and hydrostatic components, octahedral stresses, analysis of strain and strain rates, stress equilibrium and virtual work, objective stress rates.		**8**
Module : 3		
Plasticity: the criteria of yielding, isotropic and anisotropic hardening, rules of plastic flow, Levy-Mises and PrandtlReussequations,anisotropic flow rule, Hill's 1948 and 1979 yield criteria for anisotropic yielding.		**8**
Module : 4		
Upper bound theorem and its application in deformation processes like rolling, wire drawing, extrusion, forging. Lower bound theorem with a few applications. Slab method and its application in deformation process like symmetric/asymmetric rolling, forging, wire drawing and extrusion.		**8**
Module : 5		
Elastoplastic sheet bending. Analysis of autofrettage. Theory of slip line field and its application in metal forming. Heat transfer analysisin deformation processes with examples from rolling and friction stir welding/processing. Workability and dynamic materials model.		**8**
	Total	**40**
Text	1. J. Chakrabarty, "Theory of plasticity", Elsevier Butterworth-Heinemann Company, Singapore, 2006. 2. B. L. Juneja, "Fundamentals of metal forming processes", New Age International, New Delhi, 2007.	
Reference	1. P. M. Dixit and U. S. Dixit, "Modelling of Metal Forming and Machining Processes: By Finite Element and Soft Computing Methods", Springer, London, 2008. 2. W. F. Hosford and R. M. Caddell, "Metal forming: mechanics and metallurgy", Cambridge University Press, London, 2011.	