INDIAN INSTITUTE OF INFORMATION TECHNOLOGY BHAGALPUR

Mechatronics Engineering (MEA)

B.Tech. Curricula and Syllabus

Semester -IV

Course Code	Course name	L	T	P	C	Year	Semester	Semester Total Credit
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								

Syllabus:

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-1	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-2	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-3	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-4	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-5	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-1	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-2	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-3	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-4	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-5	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.

	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 -	**08**

	theories of failure - Design based on strength and stiffness - stress concentration - Design for variable loading	
Module 2	Design of solid and hollow shafts based on strength, rigidity and critical speed - Keys, keyways and splines - Rigid and flexible couplings	**08**
Module 3	Threaded fasteners - 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	**08**
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	**07**
Module 5	Sliding contact and rolling contact bearings, Hydrodynamic journal bearings, Sommerfeld Number, Selection of Rolling Contact bearings	**08**
	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

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 Robert\'s mechanism, Intermittent Motion mechanisms: Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, condition for correct steering, Ackerman steering gear mechanism.	**08**

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	**08**
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	**08**
Module 4	**Cam:** Definition, types of cam, types of followers, displacement, velocity and acceleration curves for uniform velocity, Simple Harmonic Motion, Uniform Acceleration Retradation, Cycloidal motion. Under cutting, Cam profiles: disc cam with reciprocating / oscillating follower having knife-edge, roller and 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	**07**

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	**07**
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	**07**
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	**07**
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	**08**
	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.

Contents		**No. of Lectures**
Module 1	**Introduction:** properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, 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	**8**

	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.	
Module-2	Types of Flow-steady, unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational, streamlines, 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, • Bars of constant cross section area, tapered cross section area and stepped bar • Beams –Simply supported, cantilever, beams with point load, UDL, beams with varying load • 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**