INSTITUTE OF INFRASTRUCTURE TECHNOLOGY RESEARCH AND MANAGEMENT- AHMEDABAD

Course structure and Curriculum

B. Tech in Department of Mechanical and Aerospace Engineering

Program: B. Tech. in Mechanical and Aerospace Engineering Department (2019-2023)

Sem									C
1st	Mathematics 3-2-0-5	Physics - I 2-1-0-3	HSS - 1 Technical Communication 3-0-2-4	I to I Mech 2-0-0-2	Physics + Lab 0-0-3-1.5	Chemistry 3-1-0-4	Engineering Graphics 2-0-3-3.5	Chemistry + Lab 0-0-3-1.5	**24.5**
2nd	Mathematics (ODE+ Linear Algebra + V. calculus) 4-2-0-6	Physics - II 3-2-0-5	EEE 2-1-2-4	Computer Science 2-1-3-4.5	Manufacturing Science & Workshop 2-0-3-3.5	--	--	--	**23**
3rd	HSS – 2 (Intro. to Sociology) 3-0-0-3	Complex Analysis and Differential Equations 4-2-0-6	Engineering Mechanics 3-2-0-5	Thermodynamics 3-1-0-4	Engineering Materials 3-1-2-5	Metrology Lab 0-1-2-2	Minor-1*	--	**25**
4th	Introduction to Numerical Methods 3-1-0-4	Fluid Mechanics and Machines 3-1-2-5	Manufacturing Processes 3-1-3-5.5	Strength of Materials 3-2-0-5	Applied Thermodynamics 3-1-2-5	Intro to Design and Innovation 4-0-0-4	(Honors-1)**	Minor-2*	**28.5**
5th	HSS – 3 (Introduction to Economics) 3-0-0-3	Advanced Manufacturing Processes 2-1-3-4.5	Introduction to Machine Design 3-1-0-4	Theory of Machines & Mechanisms 3-1-2-5	Heat and Mass Transfer 3-1-2-5	(Honors-2)**	Minor-3*	--	**21.5**
6th	HSS-4 Elective 3-0-0-3	CAD/CAM 2-1-3-4.5	Dynamics and Vibrations 3-1-0-4	Operations Research & Project Management 3-1-0-4	Refrigeration and Air-Conditioning 3-1-2-5	Seminar 0-0-0-2	(Honors-3)**	Minor-4*	**22.5**
7th	Open Elective 3-0-0-3	B.Tech Project -1 0-0-0-8	Open Elective 3-0-0-3	Department Elective 3-0-0-3	Industrial Engineering & Safety 3-0-0-3	Robotics and Industrial Automation 3-1-2-5	(Honors-4)**	Minor-5*	**25**
8th	B.Tech Project -2 0-0-0-16								**16**

* These are Minor courses (*Drone Technology*). The students can opt for these additional five courses (Optional).

** These are Honors courses. The students can opt for these additional four courses (Optional).

BACHELOR OF TECHNOLOGY
Mechanical and Aerospace Engineering Department
Semester - III
Course Scheme

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
HS 192001	Introduction to sociology	3	0	0	3
MA 192001	Mathematics-III (Complex Analysis and Differential Equations II)	4	2	0	6
ME 192001	Engineering Mechanics	3	2	0	5
ME 192002	Thermodynamics	3	1	0	4
ME 192003	Engineering Materials	3	1	2	5
ME192501	Metrology Lab	0	1	2	2
	Total	16	7	4	25

Mechanical and Aerospace Engineering Department

Semester: III

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">HS 192001</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Introduction to Sociology</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV</td><td>Prerequisite(If any for the student)</td><td colspan="4">Nil</td></tr>
<tr><td>V</td><td>Course Coordinators</td><td colspan="4">Dr. Shukkoor. T</td></tr>
<tr><td>VI</td><td>Course Content</td><td colspan="4">Unit- 1
Sociology:
Origin and Development; Nature, Scope and Significance; Founders of Sociol- ogy; Sociological Perspectives

Unit-2
Basic Concepts:
Society, Community, Social Structure, Status and Role; Culture, Norms and Values, Socialization; social stratification, Groups- Types of group, Social organisations; Social control; Deviance, Social change, Social protests, Social movements

Unit-3
Social Institutions- Features and Functions:
Family, Education, Economy, Religion, State

Unit-4
Social Problems- definition and characteristics:
Corruption, Unemployment, Poverty

Unit- 5
Sociology of Science and Technology: Society and Technology: Technol- ogy and Development, The Social Construction of Technology, Technology and Social Relations, Social responsibilities of scientists and technocrats, Gender and Technology</td></tr>
</table>

VII	Text/References	1. Giddens, Anthony (2013): Sociology (seventh edition), Cambridge, Polity Press 2. Das,Veena(2005): Handbookof Indian Sociology, New Delhi: Oxford University Press 3. Harlambos, M. (2014): Sociology: Themes and Perspectives, London: Harper Collins 4. MacIver and Page (1974): Society: An Introductory Analysis, New Delhi: Macmillan & Macmillan 5. Inkeles, Alex (1987): What is Sociology? New Delhi: Prentice-Hall of India 6. Johnson, Harry M. (1995): Sociology: A Systematic Introduction, New Delhi: Allied Publishers 7. Ahuja, Ram (2001): Indian Social System, New Delhi: Rawat Publication. 8. Ahuja, Ram (2003): Society in India, New Delhi: Rawat Publication. 9. Abercrombie, N., Hill, S., Turner, B.S: Dictionary of Sociology (2005): Penguin Reference

I	Course Code	MA 192001			
II	Course Title	Mathematics-III (Complex Analysis and Differential Equations II)			
III	Credit Structure	L	T	P	C
		4	2	0	6
IV	Prerequisite(If any for the student)	Nil			
V	Course Content	Complex Analysis: Definition and properties of analytics functions; Cauchy-Riemann equations, Harmonic functions; Power series and their properties;Elementary functions; Cauchys theorem and its applications; Taylor series andLaurent expansions; Residues and the Cauchy residue formula;Evaluation ofimproper integrals; Conformal mappings. Differential Equations:Laplace transforms, Shifting theorems, Convolution the- orem,Review of power series and series solutions of ODEs; Legendres equa- tionand Legendre polynomials; Regular and irregular singular points, method ofFrobenius; Bessels equation and Bessels functions; SturmLiouville prob- lems;Fourier series; DAlembert solution to the Waveequation; Classification oflinear second order PDE in two variables; Vibration of a circular mem- brane;Fourier Integrals, Heat equation in the half space			
VI	Text/References	1. Kreyszig, E., Advanced Engineering Mathematics, 8th Edition, John Wiley & Sons, 1999. 2. Boyce, W.E., and DiPrima, R., Elementary Differential Equations, 8thEdition, John Wiley & Sons, 2005. 3. Churchill, R.V., and Brown, J.W., Complex variables and applications, 7thedition, McGrawHill, 2003. 4. Churchill, R.V., and Brown, J.W., Fourier series and boundary value Problems, 7th Edition, McGraw-Hill, 2006. 5. Howie, J.M., Complex Analysis, Springer-Verlag, 2004. 6. Ablowitz, M.J., and Fokas,A.S., Complex variables: Introduction and Applications, Cambridge University Press, 1998(Indian			

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 192001</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Engineering Mechanics</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>2</td><td>0</td><td>5</td></tr>
<tr><td>IV</td><td>Prerequisite (If any)</td><td colspan="4">Nil</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Course contents:

Unit-I: Introduction
Introduction to engineering mechanics, assumptions, methods of analysis-scalars and vectors, Force system-coplanar and non-coplanar forces, collinear-non-collinear forces, concurrent forces, and non-concurrent forces, moment of force and couple, free body diagram.

Unit-II: Forces in Engineering Systems
Forces in beams: Types of Loading-Concentrated load, uniformly distributed load, uniformly varying load, Random loads, Types of Support: Free, Fixed, Hinged, SFD, BMD, Truss Analysis: Assumptions, analysis of forces intruss-method of joints, method of sections, conditions of equilibrium, nature of force system.
Friction: Introduction, laws of friction, angle of repose, cone of friction, friction on plane and inclined surfaces, wedge, belt friction, application of friction to engineering problem.

Unit-III: Centroid, Center of gravity and Moment of Inertia
Definitions: Center of gravity, centroid, center of mass, Centroid of standard sections, centroid of composite sections, centroid of wires, moments of inertia, parallel axis theorem, perpendicular axis theorem, radius of gyration, moment of inertia for standard and composite sections.

Unit-IV: Motion
Introduction to dynamics-kinematics and kinetics, Rectilinear motion: Determination of position, distance travelled, uniform motion, effect of increas- ing/decreasing velocity/acceleration, motion under gravity, relative motion, Curvilinear motion: Resolution of velocity and acceleration, tangential and normal components, radius of curvature, radial and transverse components of acceleration, Projectile Motion: Independence of horizontal and vertical motion, properties of projectile motion, projectile on inclined surfaces.

Unit-V: Kinetics of Particles
D’Alemberts Principle: D’Alemberts principle in normal and tangential components, motion of connected bodies, simple machines, circular motion, centripetal force, motion of vehicle on a level circular track, motion of vehicle on a banked circular track.
Work and Energy: work of force, energy, work of constant force in rectilinear motion, work of force exerted by spring, mechanical efficiency.</td></tr>
</table>

VI	Text/References	Textbooks: 1. Engineering Mechanics-Statics and Dynamics, S Rajasekaran and G Sankara Subramanian, 3rd Edition, Vikas Publishing House Pvt. Ltd. 2. A Textbook of Engineering Mechanics, R K Bansal, Laxmi Publications Reference Books: 1. Engineering Mechanics-Statics and Dynamics, Irving Shames and G. Krishna Rao, 4thEdition, Pearson. 2. Fundamentals of Engineering Mechanics, Vikas Publishing House Pvt Limited, 2009

I	Course Code	ME 192002			
II	Course Title	Thermodynamics			
III	Credit Structure	L	T	P	C
		3	1	0	4
IV	Prerequisite(If any)	Nil			
V	Course Content	Introductory Concepts and Definitions: Areas of Application of Thermo-dynamics, Different Approaches in the study of Thermodynamics, System, Surroundings, Types of Systems, Intensive and Extensive Properties, Thermodynamic equilibrium, Energy, Heat & Work. First Law of Thermo-dynamics: Path and point Function, Perpetual Motion Machine, Analysis of Closed Systems. Constant Pressure Process, Constant Volume Process, Specific Heat, Constant Temperature Process, Adiabatic Process. Polytropic Process, First Law of Thermodynamics for a Continuous System, Steady-state Flow Processes, Application of Steady State Flow Processes, Throttling Process, Application of Throttling Process. Properties of Pure Substances: Thermodynamic Properties of Fluids, Pure substance, Equations of State, Ideal Gas, The Van der Waals Constants, Phase-Change Process of Pure Substances, Steam Tables. Second Law of Thermodynamics, Entropy and Availability: Limitations of First Law of Thermodynamics, Heat Engine, Heat Pump, Refrigerator, KELVIN PLANCK STATEMENT, Clausius Statement of the Second Law, Reversibility, Irreversibility and Carnot cycle, Carnot Engine, Carnot'sPrinciples (Theorems), Clausius Inequality, Entropy, Principle of Entropy Increase, calculation of entropy change. Temperature Entropy Diagram & Second Law Analysis of a Control Volume, TdS Equations, Entropy changes of an incompressible substance, criterion of equilibrium, Thermodynamic definition of temperature, pressure and chemical potential, Thermodynamic potentials, Availability & Irreversibility, Availability Function, and Irreversibility. Introducing Combustion, Fuels, Modeling Combustion Air, Products of Combustion, Energy and Entropy Balances for Reacting Systems, Conservation of Energy. Enthalpy for Reacting Systems, Enthalpy of Combustion and Heating Values, Adiabatic Flame Temperature, Absolute Entropy and the ThirdLaw of Thermodynamics, Evaluating Gibbs Function for Reacting Systems. Thermodynamic Cycles: Overview of thermodynamics, Carnot Cycle, limitation of Carnot cycle, Steam Power Cycles: Rankine Cycle, Reheat Cycle, Regenerative Cycle, Binary Vapor Cycle. Gas Power Cycles: Air standard Cycles; Otto Cycle, Diesel Cycle, Dual Cycle, Comparison of Otto, Diesel & Dual Cycles, Brayton Cycle, gas power cycles with reheat, intercooling, regenerative cycle, and various combinations. Gas Turbine-Steam Turbine Combined Cycle.			

VI	Text/References	1. Thermodynamics: An Engineering Approach: Cengel Y and Boles M. McGraw Hill India, 2011. 2. Fundamentals Of Engineering Thermodynamics: Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, and Margaret B. Bailey, Willey Publication, Eighth Eddition, 2014. 3. Introduction to Thermodynamics: Rao Y V C. Orient Longman, 2009. 4. Engineering Thermodynamics: Nag P K. McGraw Hill India, 2013. 5. Fundamentals of Thermodynamics: Borgnakke C and Sonntag R E. Wiley, 2009.

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 192003</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Engineering Materials</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>2</td><td>5</td></tr>
<tr><td>IV</td><td>Prerequisite (If any)</td><td colspan="4">Nil</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Introductory Concepts and Definitions Introduction, Materials in Engineering design, the evolution of engineering materials, the families of engineering materials, modern materials, properties of engineering materials; Fundamentals, Atomic bonding, Crystalline structure-perfection/imperfection, diffusion in solids.

Engineering Materials: Structural materials and their behavior: Metals and alloys, ceramics and glasses, polymers, composites, conductors, semiconductors, optical and magnetic materials, mechanical and thermal behavior, electrical behavior, optical behavior, magnetic behavior; Corrosion and degradation of engineering materials.

Phase transformation and Heat treatments of steels: Classification of steels with applications, Theory of Heat Treatment, Phase diagram and phase transformation, TTT, CCT diagram and its implication to heat Treatment, Different heat treatments- Annealing, Normalizing, Hardening, Tempering surface treatment etc. Strengthening Mechanisms.

Material selection and design consideration: materials and industrial design, material property charts, material selection strategy and procedure, economic, advanced materials, environmental and societal issues related to engineering materials; case studies related to few engineering products/equipment.

Laboratory Experiments:

1. Tension test
2. Three point bending test
3. Compression test
4. Impact test
5. Hardness test
6. Microscopy
7. Group Project</td></tr>
</table>

VI	Text/References	1. Callister: Materials Science and Engineering: An Introduction, 6th Edition. 2. Mechanical Metallurgy by George E Dieter 3. Mechanical Behaviour and Testing of Materials by A K Bhargava and C P Sharma.

BACHELOR OF TECHNOLOGY
Mechanical and Aerospace Engineering Department

Semester: IV

Teaching Scheme

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
MA 192002	Introduction To Numerical Methods	3	1	0	4
ME 192004	Fluid Mechanics And Machines	3	1	2	5
ME 192005	Manufacturing Processes	3	1	3	5.5
ME 192006	Strength Of Materials	3	2	0	5
ME 192007	Applied Thermodynamics	3	1	2	5
ME 192008	Introduction to Design And Innovation	4	0	0	4
	Total	19	6	7	28.5

Mechanical and Aerospace Engineering Department

Semester : IV

I	Course Code	MA 192002			
II	Course Title	Introduction To Numerical Methods			
III	Credit Structure	L	T	P	C
		3	1	0	4
IV	Prerequisites	NIL			
V	Course Content	Interpolation by polynomials, divided differences, error of the interpolating polynomial, piecewise linear and cubic spine interpolation, Numerical differentiation, Numerical integration, composite rules, error formulae, Solution of a system of linear equations, Gauss elimination, Gauss Seidel methods, partial pivoting, row-echelon form, LU factorization, Cholesky's method, matrix norms, Solution of non-linear equations, Bisection and Secant methods, Picard iteration, Newton's method, Numerical solution of ordinary differential equations, Euler and Runge-kutta methods, multi- step, predictor-corrector methods, Difference equations, Stability, Finite difference methods, Eigen value problem, Gershgorin's theorem, Power and inverse power methods, QR method, Explore to software packages like R, MATLAB.			
VI	Text/References	1. S. D. Conte and Carl de Boor, Elementary Numerical Analysis-An algorithmic Approach, McGraw Hill, 1980. 2. C. E. Froberg, Introduction to Numerical Analysis, Addison-Wesley, 1981. 3. E. Kreyszig, Advanced Engineering Mathematics, Wiley India. 4. K. Atkinson and W. Han, Elementary Numerical Analysis, Wiley India, 2004. 5. WardCheney & David Kincaid, Numerical Mathematics and Computing, Cengage Learning, India Private Limited. 6. Steven C. Chapra & Raymond P. Canale. Numerical Methods for Engineers, McGraw Hill, 2012.			

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 192004</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Fluid Mechanics And Machines</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>2</td><td>5</td></tr>
<tr><td>IV</td><td>Prerequisites</td><td colspan="4">Laws of motion, Thermodynamics</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Properties of Fluids: Introduction, Fluid properties and classification; concept of viscosity, compressibility and Elasticity, Surface tension and capillarity. Newton’s law of viscosity, dynamic viscosity, classification of fluids, kinematic viscosity, variation of viscosity with temperature, Surface tension and capillarity.
Fluid Statics: Pascal law, Hydrostatic law, Relative equilibrium, Pressure measurements- atmospheric pressure, Absolute pressure, Gauge pressure, and Vacuum pressure, Piezometer, Manometers, Forces on immersed bodies: Drag and Lift.
Fluid Kinematics: Fluid flow methods of analysis of fluid motion, Streamlines, Path lines, Streak lines and Stream tubes. Types of fluid flow-Steady and unsteadyflow, Uni- form and non-uniform flow, Laminar and turbulent flow, Reynolds number, Reynolds experiment, Rotational and Irrotational flow, Subcritical, critical and Supercritical flow, Compressible and Incompressible flow-, One-,Two- and three-dimensional flow, Circulation and vorticity, Stream function and Flow net.
Fluid Dynamics: Equation of Motion: Euler’s equation, Bernoulli’s equation, Energy correction factor, Coefficients of contraction, velocity and discharge, Differential head meters, Free vortex motion, Analysis of free liquid Jet, Cavitation. Linear momentum equation, Force on pipe junctions and bends, Forces on moving plates and vanes due to fluid flow, Angular momentum, Forced vortex.
Flow Measuring Devices: Measurement of discharge-Venturimeter, Orifice meter, mouth pieces, Nozzle meter, Rotometer, Weirs, Flow under sluice gates. Time of emptying tanks with or without inflow. Measurement of velocity-Pitot tube.
Hydraulic Machines: Turbines: classification of tribunes, Impulse and Reaction turbines, characteristic curves, draft tubes, Pumps: classification of pumps, centrifugal pump, efficiency and power, Output of centrifugal pumps, characteristics curves.
Pipe Hydraulics: Review of the basic equations: continuity, momentum, and energy. Flow through closed conduits: Laminar flow, turbulent flow.
Pipe Flow Problems: Losses in pipe flow, pipes in series, pipes in parallel, branching pipes, siphons, multi-reservoir problems, pipe networks, unsteady flow in pipes, water hammer analysis.
Compressible Fluid Flow: Compressible Flow Preliminaries, Compressible Flow Through Nozzles and Diffusers, Momentum Equation for Steady One- Dimensional Flow, Velocity of Sound and Mach Number, Determining Stagnation State Properties, Analysis of One-Dimensional Steady Flowing Nozzles and Diffusers, Exploring the Effects of Area Change in Subsonic and Supersonic flow</td></tr>
</table>

VI	Text/References	1. Fluid mechanics, Frank MWhite 2. Introduction to fluid mechanics, Fox & McDonald, 3. Brief introduction to fluid mechanics, Munson, Young et al. 4. Fluid Mechanics: Fundamentals and Applications, Yunus Cengel, John Cimbala 5. Hydraulics and Fluid Mechanics, P.M. Modi and S.M. Seth, Standard Book House
VII	Laboratory Sessions	1. Momentum equation: Impact of a jet 2. Energy Equation: Verification of Bernoulli's theorem 3. Friction losses in pipes 4. Minor losses in pipe fittings 5. Pipes in series and parallel 6. Drag and Lift on Airfoil 7. Flow measurement: In pipes, using Venturimeter and orifice meter 8. Forces on immersed bodies: Fall velocity 9. Unsteady flowinpipes: Water Hammer

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 192005</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Manufacturing Processes</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>3</td><td>5.5</td></tr>
<tr><td>IV</td><td>Prerequisites</td><td colspan="4">Engineering Mechanics</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Classification of Metal Removal Processes and Machine tools: Introduction to Manufacturing and Machining, Basic working principle, configuration, specification and classification of machine tools. Turning, milling, drilling, boring, abrasive processes, super-finishing processes etc. Mechanics of Machining (Metal Cutting) and Machinability: Geometry of single point cutting tools, Conversion of tool angles from one system to another, Mechanism of chip formation, Orthogonal and oblique cutting, Use of chip breaker in machining, Machining forces and Merchant’s Circle Diagram (MCD), Analytical and Experimental determination of cutting forces, Dynamometers for measuring cutting forces, Cutting temperature – causes, effects, assessment and control, Control of cutting temperature and cutting fluid application, Concept of Machinability and its Improvement, Failure of cuttingtools and tool life, Cutting Tool Materials of common use Advanced Cutting Tool Materials.

Casting: Introduction, Solidification- Solidification of pure metals and alloys; nucleation and growth in alloys; solidification of actual castings; progressive and directional solidification; centerline feeding resistance; rate of solidification; Chvorinov’s Rule, Risering- Riser design, Gating- Gating systems and their characteristics; the effects of gates on aspiration; turbulence and dross trap, Patterns, Inspection and Quality Control.

Metal Forming and Sheet Metal Working: Elastic and plastic de- formation. Concept of strain hardening. Hot and cold working processes -rolling, forging, extrusion, swaging, wire and tube drawing. Machines and equipment for the processes. Analysis of stress and strains, Yield criteria, Parameters and forcecalculations. Test methods for formability. Specific roll pressure, Rolling load, Rolling torque, Blanking, Punching, piercing, bending, drawing etc. Analysis of drawing of circular wires, Forces in blanking, Stresses and strains in bending.

Welding: Introduction: Principle of welding, general applications such as construction of bridges, towers, automobiles & electronic circuits, etc. Classification of welding processes, Soldering and brazing. Welded Joints: Introduction to AWS standards. Manual metal arc (MMA) or shielded metal arc (SMA) welding, Submerged arc welding (SAW). Gas metal arc welding (GMAW) or MIG/MAG welding, TIG welding, Resistance welding. Current–voltage characteristic of arc, Effects of change in arc current for change in arc length, Heat flow characteristics.</td></tr>
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	Course Content	Introduction to Plastics & their Processing: Introduction to plastics, Injection moulding, Extrusion, Blow moulding, calendaring, etc. Jigs and Fixtures: Purposes of jigs and fixtures and their Design principles, Design and Application of typical jigs and fixtures. Laboratory Experiments: 1. Cutting forces measurement during machining using Dynamometer. 2. Determination of surface roughness after various machining operations. 3. Making of Single point cutting tool using tool & cutter grinder and study of tool signature. 4. Tool wear measurement using toolmaker's microscope. 5. To produce various welding joints using MIG and SPOT welding. 6. Fabrication of different sheet metal objects using development of surfaces. 7. Experiments on press working (Hydraulic and Manual). 8. Demonstration of various Jigs and Fixtures.
VI	Text/References	1. Serope Kelpekijian & Stefan R. Schmidt. Manufacturing Processes for Engineering Materials, 2007 2. Shaw.M.C. Metal cutting principles, Oxford Clare Don Press, 1984. 3. Bhattacharya.A, Metal Cutting Theory and Practice, Central Book Publishers, India, 1984. 4. Boothroid D.G. & Knight W.A., Fundamentals of machining and machine tools, Marcel Dekker, Newyork, 1989. 5. Fundamentals of Metal casting, Flinn, Addison Wesley. 6. Dieter G.E., Mechanical Metallurgy (Revised Edition II) McGraw Hill Co., 2004 7. ASM Handbook Vol.6. Welding Brazing & Soldering, 2003

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 192006</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Strength of Materials</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>2</td><td>0</td><td>5</td></tr>
<tr><td>IV</td><td>Prerequisites</td><td colspan="4">-</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Stress Measures: Introduction - Analysis of mechanical systems, Rigid and deformable solids, Equilibrium conditions, Simple stresses- Tension, Compression and Shear, Thermal stresses, Stresses on oblique planes, principal stresses and principal planes, State of stress-2D plane stress & strain,3D. Mohr's circle of stress, Residual Stresses.

Strain measures: Fundamental definition of strain, Volumetric strains,Poisson's ratio, Multiaxial loading-Genaralized Hooke's law, Bulk and Shear Modulii, Saint Venant's principle.

Failure Theories: Microscopic and Macroscopic failures, Yield surface, Rankine, Von Mises and Tresca criterion.

Torsion formula, stresses and deformation in circular and hollows shafts – Angle of twist in elastic range, statically indeterminate shafts, combined stresses due to axial and torsional loads.

Energy Methods: Strain Energy, Strain-Energy Density, Elastic Strain Energy for Normal and Shearing Stress, Impact Loading, Work and Energy under a Single Load, De- flection under Single and multiple loads, Castigliano's theorem and applications.

Elastic stability
Notion of stability of equilibrium, elastic instability and buckling, Euler load.</td></tr>
<tr><td>VI</td><td>Text/References/ Recommended</td><td colspan="4">Recommended Books

1. Ferdinand Beer, E. R. Johnston and John Wolf, 'Mechanics of Materials', Tata McGraw Hill, 3rd edition, 2004.

Reference Books

1. William Hosford, Solid Mechanics, Cambridge University press, 2010.
2. Sadhu Singh, 'Strength of Materials', Khanna Publishers, 8th edition 2003.
3. R. K Bansal 'Strength of Materials' Laxmi Publications, 4th ed 2007</td></tr>
</table>

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 192007</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Applied Thermodynamics</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>2</td><td>5</td></tr>
<tr><td>IV</td><td>Prerequisites</td><td colspan="4">Thermodynamics</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Vapour Power and Steam Turbines: Steam Generator: Mounting and Accessories, Circulation, fuels and combustions. Steam Nozzles: Types of nozzles, critical pressure ratio and condition for maximum discharge, nozzle efficiency. Steam Turbine: Principle and types of steam turbines, compounding of steam turbines, velocity diagram and analysis of steam turbine, condition for maximum efficiency, degree of reaction, reheat factor, governing of steam turbine – throttle, nozzle and bypass governing, Losses in steam turbine, cogeneration. Back pressure, pass out and mixed pressure turbine.

Internal Combustion Engine and Gas Turbines: Fuels, Fuel air cycle, actual cycle, SI and CI engines, Combustion in SI and CI engines, Carburetors, Fuel injection, MPFI, performance analysis of the IC engine, Lubrication and cooling system, Hybrid engine
Gas Turbine: Principle and Classification, optimum pressure ratio for maximum thermal efficiency, work ratio, air rate, effect of operating variables on the thermal efficiency and work ratio, and air rate, analysis ofgas turbine.

Gas Compressors
Compressor: Classification; single and multistage; effect of intercooling in reciprocating compressors; volumetric efficiency and power requirement. Centrifugal compressor: classification, energy transfer equations, elementary theory, vector diagram efficiencies; elementary analysis of axial compressors. Roots blower, performance analysis.</td></tr>
</table>

VI	Text/References	Textbooks 1. P.K. Nag, "Engineering Thermodynamics" – Tata McGraw-Hill Publishing Company Ltd., 4th Ed., 2008. 1. ichael J. Moran, Howard N. Shapiro, Daisie D. Boettner, and Margaret B. Bailey; Fundamentals Of Engineering Thermodynamics:, Willey Publication, Eighth Edition, 2014. 2. T. D. Eastop & A. McConkey, "Applied Thermodynamics" – Pearson Education, 5th Ed., 2008. 3. Rayner J., "Basic Engineering Thermodynamics" – Pearson Education, 5th Ed., 2008. 4. Claus Borgnakke & Richard E. Sonntag, "Fundamentals of Thermodynamics", John Wiley & Sons, 7th Ed., 2009. 5. M.J. Moran and H.N. Shapiro, Fundamentals of Engineering Thermodynamics (6th Edition), Wiley (ISBN: 978-471-78735-8). 6. Y.A. Cengel and M.A. Boles, Thermodynamics: An Engineering Approach (6th Edition), Tata McGraw Hill, New Delhi, 2008. (ISBN: 0070262179). Reference Books
VII	Laboratory Sessions	1. Study of Various Types of Boilers 2. To Study Boiler Mountings & Accessories 3. To study the working of impulse and reaction steam turbines. 4. Tofind dryness fractionof steambyseparating and throttling calorimeter. 5. To study the constructional details & working principles of two-stroke petrol/ four-stroke petrol Engine. 6. To study the constructional details & working principles of two-stroke Diesel / four-stroke Diesel Engine. 7. Analysis of exhausts gases from petrol/diesel engine 8. Tofind the indicated horse power (IHP) on multi-cylinder diesel engine / petrol engine 9. To prepare variable speed performance test of petrol engine/diesel engine and prepare the curve (i)bhp, ihp, fhp Vs Speed (ii) Volumetric efficiency & indicated specific fuel consumption Vs Speed.

I	Course Code	ME 192008			
II	Course Title	Introduction to Design & Innovation			
III	Credit Structure	L	T	P	C
		4	0	0	4
IV	Prerequisites	Nil			
V	Course Content	Introduction: Introduction to design, modern product development process, reverse engineering and redesign, examples of product development process. Product Development Process Tool: Product development teams, team structures, team building, team evaluation, product development planning, scheduling tools. Scoping Product Development: What to develop? Mission statement, Technical questioning, technical feasibility, S curve Concept of ideal design, conceptualizing product: Identifying the customer needs, understanding the customer needs, organizing & prioritizing customer needs, affinity diagram, customer use pattern Establishing Product Function: Functional decomposition, FAST method, creating function structure, function structure modelling process. Product tear down and experimentation: Tear down process, tear down methods, application of product tear down. Benchmarking & Engineering Specification: Benchmarking approach, example, supporting tool for benchmarking, intended assembly cost analysis, function form diagram, setting product specifications, specification process, house of quality/quality function deployment (QFD). Concept generation: Concept generation process, traditional brainstorming, brain ball method, C sketch/6-3-5 method, example. Concept selection: Concept selection process, Pugh concept selection chart, concept screening and concept scoring. Concept embodiment: process of concept of embodiment, advanced method, FMEA Industrial design: Goal, importance of ID, assessment of quality of product based on ID, ID process, design challenges that ID face, technological or user driven products based on ID.			
VI	Project	Open Ended Projects which will trigger the innovation of students towards design improvement or design modification, updatation of system or product. Students will be encouraged to perform projects which can improve any system/product/machine/technology. Students will be advised to apply the product design process and various tools that is discussed in the class to develop/improve any system/product.			
VII	Textbooks	1. Kevin Otto and Kristin Wood, “Product Design: Techniques in Reverse Engineering and New Product Development”, 1/e, 2004, Pearson Education, New Delhi 2. Engineering Design, 5th Edition by George E. Dieter and Linda C. Schmidt. McGraw Hill, 2013.			

VIII	References	1. Karl T. Ulrich and Steven D. Eppinger, “Product Design and Development”, Tata McGraw-Hill Edition, New Delhi, 2003 2. Engineering Design: A Project Based Introduction, 4th Edition by Clive L. Dym, Patrick Little, and Elizabeth J. Orwin. Wiley India, 2015.

BACHELOR OF TECHNOLOGY

Mechanical and Aerospace Engineering Department

Semester - V

Course Scheme

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
HS 203001	HSS – 3 (Introduction to Economics)	3	0	0	3
ME 203001	Advanced Manufacturing Processes	2	1	3	4.5
ME 203002	Introduction to Machine Design	3	1	0	4
ME 203003	Theory of Machines & Mechanisms	3	1	2	5
ME 203004	Heat and Mass Transfer	3	1	2	5
	Total	14	4	7	21.5

<table>
<tr><td>I</td><td>Course Code. :</td><td colspan="4">HS 213001</td></tr>
<tr><td>II</td><td>Course Title :</td><td colspan="4">Introduction to Economics</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credits:</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV</td><td>Prerequisites (if any)</td><td colspan="4">Intermediate in any discipline with analytic bend of mind is required to take up this paper. 12th standard mathematical knowledge will also be helpful for the successful completion of this paper.</td></tr>
<tr><td>V</td><td>Course description and contents:</td><td colspan="4">The purpose of Introduction to Economic course is to introduce the engineering student to the discipline of economics to impart the knowledge of economics as a subject and its importance while business in the field of engineering. Now –a-days, the business decisions are made scientifically on the basis of all available information. So understanding and interpreting basic economic concepts/variables for e.g. demand and supply functions, forecasting demand, productions, costs, will make them aware of various operations carried in business.

After imparting knowledge of these concepts they would be better equipped to understand various market structures, understanding of different pricing techniques that will be introduced in the class. These concepts will help them to understand day to day business decisions being taking by different firms (in different industries) in lieu of consumer behaviour in economic, social and to an extent in ethical manner.

The second part of course examines different macroeconomic factors e.g. GDP, Inflation, Unemployment, Exchange rate and review how government policies influence macroeconomic outcome and performance of business. The last part of the course examines the time value of money and how engineers use the time value of money to make important economic decisions. In this section, we examine how interest rates and different compounding periods influence the future value of various capital investments</td></tr>
</table>

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 203001</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Advanced Manufacturing Processes</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>1</td><td>3</td><td>4.5</td></tr>
<tr><td>IV</td><td>Prerequisite</td><td colspan="4">Manufacturing Processes</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Introduction to Advanced Manufacturing Processes; Sustainable manufacturing; Unconventional machining processes and their comparative evaluation; Fundamentals of Additive manufacturing; Advanced analysis of steels and non- ferrous alloys; Advanced modeling tools for manufacturing; Foundations of industrial finite element codes for heat treatment, machining and forming processes. Simulation of different manufacturing processes with FE packages and their experimental validation. Plastics and Composite material manufacturing. Introduction to micro/nano manufacturing. Industry oriented project.
Laboratory Experiments:
1. Basic practical skills on mechanical machining, data acquisition, filtering and analysis skills.
2. Simulation of forming and machining processes using FE package DEFORM 3D and their experimental validation.
3. Use of ANSYS and MATLAB for analyzing and solving manufacturing problems.
4. Creating 3D models of components using different CAD software and building prototypes using 3D printing machine.
5. Experimental investigation of weld quality using TIG and MIG welding techniques.
6. Demonstration on Wire-cut EDM.
7. Demonstration on Ultrasonic machining setup.
8. Composite manufacturing.</td></tr>
</table>

VI	Text/References	1. Ghosh and Mallik, Manufacturing Science, EWP Private Ltd. 2. Hassan Abdel, Gabad El Hoffy, Advanced Manufacturing Processes, McGraw Hill. 3. V.K.Jain, Advance Machining Processes, Allied Publisher Bombay. 4. Pandey P.C., Shan H.S., Modern Machining Processes, Tata McGraw-Hill Education. 5. Weller E.J., Non-traditional Machining Processes, Society of Manufacturing Engineers, Publications. 6. Stephen P. Campbell, The Science and Engineering of Micro-fabrication, Oxford University Press. 7. Gibson, Rosen, Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing. Springer, 2009. 8. Davim, J.P, Machining Composite Materials, Wiley-ISTE, 2009. 9. Fluhrer, J. SFTC Inc. DEFORM 3D User's Manual. 10. Works, M. Matlab User Manual Versionr2015b. Math Works Incorporation, Natick, MA.

I	Course Code	ME 203002			
II	Course Title	Introduction to Machine Design			
III	Credit Structure	L	T	P	C
		3	1	0	4
IV	Prerequisite	Nil			
V	Course Content	Fundamentals of machine design: Design philosophy, Engineering Materials, Brief overview of design and manufacturing Stresses in machine elements: Simple stresses, Compound stresses in machine parts, Strain analysis Design for Strength: Design for static loading, Stress Concentration, Design for dynamic loading, Low and high cycle fatigue, Endurance limit Fasteners: Types of fasteners: Pins and keys, Cotter and knuckle joint, Threaded Fasteners, Design of bolted joints Couplings: Introduction, types and uses, Design procedures for rigid and flexible rubber-bushed couplings Power Screws: Power Screw drives and their efficiency, Design of power screws Design of Springs: Introduction to Design of Helical Springs, Design of Helical Springs for Variable Load, Design of Leaf Springs Design of Shaft: Shaft and its design based on strength, Design of shaft for variable load and based on stiffness. Design of Permanent Joints: Riveted Joint Types and Uses, Design of Riveted Joints, Welded Joints Types and Uses, Design of Welded Joints, Design of Adhesive Joints Design of Joints for Special Loading: Design of Eccentrically Loaded Bolted/Riveted Joints, Design of Eccentrically Loaded Welded Joints, Design of Joints with Variable Loading Design of clutches: Design of friction clutches, Design of Centrifugal clutches.			
VI	Text/References	1. Design of Machine Elements by Bhandari V. B., Third Edition, McGraw Hill Education, 2010. 2. Shigleys Mechanical Engineering Design by Budynas R. G., and Nisbett J. K., Tenth Edition, McGraw Hill Education, 2016. 3. Machine Design An Integrated Approach by Norton R. L., Fifth Edition, Pearson India, 2013. 4. Design of Machine Elements by Spotts M. F., Shoup T. E., and Hornberger 5. L. E., Eigth Edition, Pearson India, 2003. 6. A Textbook of Machine Design by Kurmi R. S., and Gupta J. K., S. Chand Publishers, 2005.			

I	Course Code	ME 203003			
II	Course Title	Theory of Machines & Mechanisms			
III	Credit Structure	L	T	P	C
		3	1	2	5
IV	Prerequisite	None			
V	Course Objective	This course introduces students to the basic concepts of mechanisms and machines and their kinematic analysis. The theoretical foundation, upon which advanced courses such as Machine Design, Dynamics and Vibration, and Robotics are built.			
VI	Course Content	Introduction: Definitions of Machine, Mechanism, Links, and Pairs; Classification of Mechanisms; Mobility - Kutzbach Equation and Griibler's Criterion; Kinematic Inversion; Grashof 's Law Kinematic Analysis and Synthesis: Position and Displacement, Velocity, Acceleration - Graphical and Analytical Methods; Coupler-Curve Generation; Instantaneous Centres of Velocity and Acceleration; Aronhold- Kennedy Theorem of Three Centres; Type, Number and Dimensional Synthesis; Function Generation, Path Generation, and Body Guidance; Coupler Curve Synthesis Cams, Gears, and Mechanism Trains: Classificationof Cams and Followers, Displacement Diagrams, Graphical Layout of Cam Profiles, Standard Cam Motions; Fundamental Law of Toothed Gearing,Spur Gears, Helical Gears, Bevel Gears, Worms, and Worm Gears; Parallel- Axis Gear Trains, Epicyclic Gear Trains, Differentials Introduction to Robotics: Kinematics of Open Chains, Topological Arrangement of Robotic Arms, Forward and Inverse Kinematics Laboratory Work: Graphical Analysisof Selected Planar Mechanisms; Cams and Gears; Computer Modelling; Mechanism Design Group Project			
VII	Text/References	1. John J. Dicker Jr., Gordon R. Pennock, and Joesph E. Shigley, Theory of Machines and Mechanisms, Fourth Edition (International Version),Oxford University Press, 2015. 2. Amitabha Ghosh, and Ashok K. Mallik, Theory of Mechanisms and Ma chines, Third Edition, East West Press Private Limited, 1998. 3. Robert L. Norton, Kinematics and Dynamics of Machinery, First SI Edition, McGraw Hill Higher Education, 2008. 4. S. S. Rattan, Theory of Machines, Fourth Edition, McGraw Hill Higher Education, 2014.			

I	Course Code	ME 203004			
II	Course Title	Heat and Mass Transfer			
III	Credit Structure	L	T	P	C
		3	1	2	5
IV	Prerequisite	Thermodynamics			
V	Course Content	Introduction, Modes of heat transfer: Conduction, Convection, Radiation, Material properties of importance in heat transfer, Thermal conductivity, Specific heat capacity. Conduction: One Dimensional steady-state conduction through homogeneous and composite plane walls, One-dimensional steady-state conduction through cylinders and spheres, Critical thickness of insulation, Heat transfer from fins of uniform cross section, Heat conduction in bodies with heat sources, Transient heat conduction, Lumped system analysis, Numerical methods in heat conduction. Convection: Free and Forced, Fundamentals, Velocity and thermal boundary layer, Conservation equations for mass, momentum and energy, solution of boundary layer equations. Non-dimensional numbers, Laminar and turbulent flows, External forced convection: Drag and heat transfer, parallel flow over flat plates, flow across cylinders and spheres, Internal forced convection: Mean velocity and mean temperature, entrance region, constant heat flux and temperature condition in pipe flow, Hagen Poiseuille flow, Turbulent flow and heat transfer, Natural/free convection: Equation of motion of Grashof number, natural convection over surfaces and inside enclosures Thermal Radiation, Kirchoffs law; Plancks distribution law, Wiens displacement law. Stefan-Boltzmanns relation, Configuration factors, Radiant interchange between black and grey surfaces, Radiation shielding solar radiation. Heat exchanger, Combined heat transfer analysis, overall heat transfer co-efficient, Types of heat exchangers, LMTD and NTU methods of heat exchanger design, Simple heat exchanger calculations. Boiling and condensation, Boiling heat transfer: pool boiling and flow boiling, Condensation heat transfer, film condensation Mass Transfer, Introduction, analogy between heat and mass transfer, mass diffusion, Ficks Law, boundary conditions, Steady mass diffusion through a wall, cylinder and sphere, Transient mass diffusion, mass transfer in a moving medium, diffusion of vapor through a stationary gas: Stefan Flow.			

	Laboratory Experiments:	1. Heat Conduction and Convection Through Extended Surface 2. Unsteady State Heat Transfer 3. Heat Transfer in Natural Convection 4. Laws of Radiant Heat Transfer and Radiant Heat Exchange 5. Dropwise and Filmwise Condensation 6. Heat Transfer Through Lagged Piple 7. Critical Heat Flux 8. Parallel and Counterflow Heat Exchanger 9. Diffusion in Liquids and Gases
VI	Text/References	1. Holman JP and Bhattacharya S, Heat Transfer, 10th Edition, McGraw Hill Education. 2. Incropera, F.P. and DeWitt, D.P., Principles of Heat and Mass Transfer, 7th Edition, Wiley publications. 3. Nag, P.K. (2002). Heat and Mass Transfer, TMH. 4. Thirumaleshwar, M. (2006). Fundamentals of Heat and Mass Transfer, Pearson education. 5. Ghoshdastidar, P.S. (2004). Heat Transfer. Oxford University Press. 6. Arora, Domkundwar, S. and Domkundwar, A. (1988). A Course in Heat & Mass Transfer, Dhanpat Rai & Co. 7. Incropera, F.P. and DeWitt, D.P. (2002). Fundamentals of Heat and Mass Transfer, John Willy & Sons, New York, NY. 8. John R.Howell& Richrd O Buckius, Fundamentals of Engg. Thermodynamics, McGraw Hill International. 9. Holman, J.P. (1997). Heat Transfer, 9th edition, McGraw-Hill. 10. Mills, A.F. (1999). Basic Heat and Mass Transfer. Prentice-Hall

BACHELOR OF TECHNOLOGY

Mechanical and Aerospace Engineering Department
Semester - VI

Teaching Scheme

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
HS 18XXX	HSS-4 Elective	3	0	0	3
ME 213001	CAD/CAM	2	1	3	4.5
ME 213002	Dynamics and Vibrations	3	1	0	4
ME 213003	Operations Research & Project	3	1	0	4
ME 213004	Refrigeration & Air Conditioning	3	1	2	5
ME 223600	Seminar	0	0	0	2
	Total	14	4	5	22.5

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 213001</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">CAD/CAM</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>2</td><td>1</td><td>3</td><td>4.5</td></tr>
<tr><td>IV</td><td>Prerequisite</td><td colspan="4">None</td></tr>
<tr><td>V</td><td>Course Objective and Scope</td><td colspan="4">1.Basic introduction on hardware and software requirement of CAD.
2.Understand the mathematical and physical principles underlying geometric modelling.
3.Complete practical exposure on geometric modelling using CAD modelling tools.
4.Understanding in brief about Computer aided manufacturing.</td></tr>
<tr><td>VI</td><td>Course Content</td><td colspan="4">Computer Aided Design
1. Introduction of Computer Aided Design; The Design Process
2. Product Life Cycle; Application of CAD
3. Hardware Requirements of CAD: Principles of interactive computer graphics; Overview of hardware available for use in CAD
4. Geometric Modeling − Curves: Types of mathematical representation of curves; Analytical Curves − Lines, Circle, Ellipse, Parabola, Hyper- bola; Synthetic Curves − Hermite cubic splines, Bezier Curves, B-splines, NURBS
5. Geometric Modeling − Surfaces: Analytical Surfaces; Surfaces of Revolution; Mathematical Representation of Surfaces, Surface Model, Surface Entities, Surface Representation; Parametric Representation of Surfaces, Plane Surface, Rule Surface; Surface of Revolution; Tabulated Cylinder 6.
6. Solid Modeling: Solid Representation; Boundary Representation (B-rep); Constructive Solid Geometry (CSG)
7. 2-D and 3-D Geometric Transformations: Translation, Rotation, Scaling; Mirror Concatenation; Coordinate Tranformations
Computer Aided Manufacturing
1. Product Data Exchange: Graphics Standards − GKS, Bitmaps, Open GL; Data Standards − IGES, STEP, CALS, DXF, STL; Communication Standards − LAN, WAN
2. Engineering Tolerance and Geometric Tolerance
3. Computer Aided Process Planning: CAPP Benefits, Models, Approach; Hybrid CAPP
4. Computer Integrated Manufacturing: Integrating CAD/CAM/NC; Ma- chine Tools; NC Programming; Tool Path Generation; Tool Path Verification</td></tr>
</table>

VII	Textbooks/ References	1. Rogers D. F. and J. A. Adams, “Mathematical Elements of Computer Graphics”, TataMcGraw-Hill, New York,2004. 2. Ibrahim Zeid, “Mastering CAD/CAM”, Tata McGraw-Hill, New Delhi, 2005. 3. P. Radhakrishnan, S. Subramanyan, V. Raja, “CAD/CAM/CIM” New AgeinternationalPublishers. 4. CAD/CAM by Chirs McMohan and Jimmy Browne, Pearson.

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 213002</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Dynamics and Vibrations</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>IV</td><td>Course Content</td><td colspan="4">Dynamics
Newtonian dynamics of a particle, systems of particles and of a rigid body; Force, torque, impulse, momentum, angular momentum,energy, and vibrations; Two-dimensional rigid-body kinematics including motion relative to a moving frame; Brief introduction to three dimensional rigid-body dynamics;

Vibrations
Single degree of freedom system; Free and forced vibrations(harmonic and general), types of damping; Duhamels integration; Two degree of freedom system; Modal analysis, diagonalization, eigensystem, response calculations for general excitation, proportional damping; Principle of virtual work, Lagranges equations. Balancing,

Gyroscope
Principle of gyroscope, Definition of axes, active and reactive couples; Roll, Yaw and Pitch motions; Gyroscopic effect in a rotor, two wheelers, Four wheelers, ship and aeroplane.

Balancing
Concepts and types of balancing, Effects of unbalanced masses, Balancing of revolving masses in same plane, Balancing of reciprocating masses, Balancing of reciprocating masses</td></tr>
<tr><td>V</td><td>Textbooks/References</td><td colspan="4">1. Principles of Dynamics by Greenwood D. T., 2nd Edition, Prentice Hall,1987
2. Classical Mechanics by Goldstein H., Addison-Wesley, 1980.
3. Dynamics of Multibody Systems by Roberson R. E., and Schwertassek R.,Spinger-Verlag, 1988.
4. Mechanical Vibrations — SI Edition — Sixth Edition — By Pearson. by Singiresu S. Rao</td></tr>
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<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 213003</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Operations Research & Project Management</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>IV</td><td>Prerequisite</td><td colspan="4">None</td></tr>
<tr><td>V</td><td>Course Objective</td><td colspan="4">To understand the different types of decision making environments and the appropriate decision making approaches and tools to be used and to develop critical thinking and objective analysis of decision problems. This course will provide students with:
• ability to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively
• knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry</td></tr>
<tr><td>VI</td><td>Course Content</td><td colspan="4">Introduction: Origin and development of operations research, general methodology of OR, applications of OR to industrial problems.
Introduction to linear programming: Different types of models, formulation of linear programming problems (LPPs), product mix problems, deterministic models, graphical solution.
Linear Programming (Simplex Method): Various steps in solving or problems using simplex method (a) Maximization problems, (b) Minimization problems, minimisation problems (all constraints of the type <), BIG ‘M’ method. Minimising case − constraints of mixed types (< and >), Maximisation case-constraints ofmixed type.
Duality and Sensitivity: Duality and its concept, dual linear programming, application of elementary sensitivity analysis.
Transportation problem: Balanced Transportation Problem, Unbalanced Transportation Problem, Method of Solution, Degeneracy and the Transportation Problem, Testing the Solution for Optimality, Solution of Unbalanced Transportation Problem, Maximization and the Transportation Techniques.
Assignment Model: Assignment Table, Method of Solving Assignment Problems.
Network optimization: Network Optimization Models, Example, The Terminology of Networks, The Shortest-Path Problem, The Minimum Spanning Tree Problem, The Maximum Flow Problem.
PERT/CPM: Using a Network to Visually Display a Project, scheduling a Project with PERT/CPM, Dealing with Uncertain Activity Durations, An Evaluation of PERT/CPM. Queuing Theory: Queuing systems and concepts, classification of queuing situations; Kendall’s notation, solution of queuing problems, single channel, single stage, finite and infinite queues with Poisson arrival and exponentialservice time, applications to industrial problems. Forecasting: Judgmental Forecasting, Time Series, Forecasting Errors Inventory Model: Components, Deterministic, Continuous-Review, Models, Deterministic, Periodic-Review Model</td></tr>
</table>

VII	Textbooks/ References	1. Taha H. A., 2008. Operations Research, 8th edition, Pearson Education, New Delhi. 2. Hillier F. S., Lieberman G. J., 2012. Introduction to Operations Research, 9thedition, McGraw-Hill Higher Education, New Delhi. 3. Ronald L. Rardin, 1997. Optimization in Operations Research, Pearson Education, Prentice Hall. 4. Sharma S. D., 2010. Operations Research, 16th edition, Merrath: Kedarnath Ramnath Publication.
VIII	Course Outcome	Upon completion of the subject, students will be able to: • recognize the importance and value of Operations Research and formulate a managerial decision problem into a mathematical model in solving practical problems in industry. • understand Operations Research models and apply them to real-life problems.

I	Course Code	ME 213004			
II	Course Title	Refrigeration & Air-Conditioning			
III	Credit Structure	L	T	P	C
		3	1	2	5
IV	Prerequisite	Knowledge of basic thermodynamics and thermodynamic cycles.			
V	Course Objective	The course is designed to give an in-depth study of theory of advanced refrigeration and air-conditioning and their applications. The techniques of analysis and design of refrigeration and air conditioning systems will also be discussed. This course will help the students to understand the underlying principles of operations in different Refrigeration & Air conditioning systems and components. It will also provide knowledge on design aspects of Refrigeration & Air conditioning systems.			
VI	Course Content	Introduction & Review, the second law interpretation, the Carnot principle, Limitation of Carnot cycle, COP, Refrigerants, Designation of refrigerants, comparative study, selection of refrigerant, Chemical and physical requirements. Gas cycle refrigeration reversed Brayton cycle, Aircraft refrigeration, Joule-Thomson coefficient and inversion curve, reversed Stirling cycle, air liquefaction. Vapour compression system, Limitations and Modification in reversed Carnot Cycle, Vapour compression cycle, Vapour compression system calculation, Effect of operating conditions on Vapour compression cycle. Actual Vapour compression cycle, Multistage compression, Multi evaporative systems, Cascade systems, Dry Ice. Introduction and analysis to CO2 trans-critical cycle. Refrigeration components, Compressors, Principle and performance of reciprocating compressor, rotary and centrifugal compressors, selection criteria of compressor in refrigeration. Condensers Types, Heat transfer in condensers, Wilson's plot. Evaporators Types, Heat transfer in evaporators, augmentation of boiling heat transfer. Expansion Valves, Types of expansion devices, constant pressure and thermostatic expansion valve, capillary tube design. Vapor absorption system, Single effect water - Lithium Bromide absorption chiller, Vapour absorption system, Double effect H2O-LiBr2 absorption system, Electrolux refrigerator. Psychrometry of air-conditioning processes, Psychrometric properties, psychrometric chart, Basic processes in conditioning of air, Psychrometric processes in air-conditioning equipment, cooling tower, Summer air- conditioning, Winter air-conditioning. Analysis of cooling towers. Load Calculations Cooling & Heating, Design conditions, solar radiations, heat transfer through building structure, Heat gains, cooling and heating load estimate, Psychrometric calculations and selection of air-conditioning apparatus cooling and dehumidification. Transmission and distribution of air, Friction loss and dynamic losses in ducts, Air ow through simple duct system, air duct design Transmission and distribution of air in rooms, centrifugal and axial flow fans and fan arrangements.			

		Laboratory Experiments: 1. Experiments on Vapour compressor system with Multi Condenser, Multi Evaporator Multi, and Expansion Valve to Conduct COP 2. Experiment on Ice plant. 3. Experiments on Heat pump with vapour compression systems. 4. Experiments on Trans-critical CO2 refrigeration systems for heating cooling. 5. Experiments on Vapour Absorption system. 6. Experiments on Cooling tower experiments. 7. Experiments on Air Conditioning Experiments for year round application with direct and indirect operation.
VII	Course Outcome	Upon completion of this course, the students can demonstrate the operations in different Refrigeration & Air conditioning systems and also be able to analyze and design Refrigeration & Air conditioning systems.
VIII	Textbooks/ References	1. Arora, C.P., Refrigeration and Air Conditioning, 3rd edition, McGraw Hill, New Delhi, 2012. 2. Roy J. Dossat, Principles of Refrigeration, 4th edition, Pearson Education Asia, 2009. 3. Stoecker, W.F. and Jones J. W., Refrigeration and Air Conditioning, McGraw Hill, New Delhi, 1986. 4. ASHRAE Hand book, Fundamentals, 2012. 5. Jones W.P., Air conditioning engineering, 5th Edition, Elsevier Butterworth-Heinemann, 2001. 6. Manohar Prasad, Refrigeration and air-conditioning, Wiley Eastern Ltd, 1983. 7. Edward G. Pita, Air Conditioning Principles and Systems, 4th Ed., Pear- son Education Asia, 2003.

BACHELOR OF TECHNOLOGY

Mechanical and Aerospace Engineering Department
Semester - VII
Teaching Scheme

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
ME 214001	Industrial Engineering and safety	3	0	0	3
ME184002	Robotics and Industrial Automation	3	1	2	5
ME 4501	B. Tech Project I	0	0	0	8
ME 400X	Open Elective - I	3	0	0	3
ME 400X	Open Elective - II	3	0	0	3
ME XXXX	Department Elective	3	0	0	3
	Total	15	1	2	25

List of Department Electives:

1. Introduction to Climate Change
2. Advance Optimization Methods in EA
3. Logistics & Supply Chain Management
4. Mechatronics
5. Introduction to CFD
6. Automobile Engineering
7. Power Plant Engineering
8. Design of Experiment
9. Numerical Heat Transfer

<table>
<tr><td>I.</td><td>Course Code</td><td colspan="4">ME 214001</td></tr>
<tr><td>II.</td><td>Course Title</td><td colspan="4">Industrial Engineering and Safety</td></tr>
<tr><td rowspan="2">III.</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV.</td><td>Prerequisites</td><td colspan="4"></td></tr>
<tr><td>V.</td><td>Course objective</td><td colspan="4">The course is distinctive in its emphasis on quantitative, economic, computer-aided approaches to production and service management problems. It is focused on providing an experimental and mathematical problem-formulating and problem-solving framework for industrial engineering work. The curriculum provides a broad
foundation in the current ideas, models, methods and safety of industrial engineering.</td></tr>
<tr><td>VI</td><td>Course Content</td><td colspan="4">Definition, Role of Industrial Engineer, Organization, Types of Organization, Break Even Analysis.
Location Selection and Plant Layout: Nature, Decision capabilities and its importance of Plant Location, Dynamic Nature of Plant Location, Optimal of site for selection, Comparison of location, Principles of Plant layout and Types, factors affecting layout, methods, factors governing flow pattern, travel chart, analytical tools of plant layout, layout of manufacturing shop floor, repair shop, services sectors and process plant. Quantitative methods of Plant layout.
Production Planning and Control: Types of Production systems and their Characteristics, functions and objectives of Production Planning and Control, Sales forecasting: Techniques and Applications, Steps of Production Planning and Control: Process planning, Leading, Scheduling, Dispatching and Expediting with illustrative examples, Introduction to line of balance, assembly line balancing, and progress control.
Productivity and Work Study: Definition of productivity,application and advantages of productivity improvement tools, reasonsfor increase and decreases in productivity. Areas of application of work study in industry. Reaction of management and labor to work study.
Method Study: Objectives and procedure for methods analysis, Recording techniques, Operations Process Chart, Flow Process Chart, Man-Machine, Multiple Activity Chart, Travel Chart, and Two Handed process chart, String Diagram, Therbligs,
Micro motion and macro-motion study: Principles motion economy, Normal work areas and work place design.
Work Measurement: Objectives, Work measurement techniques- time study, work sampling, pre-determined motion time standards (PMTS) Determination of time standards. Observed time, basic time, normal time, rating factors, allowances, and standard time.</td></tr>
</table>

		Job Evaluation and Wage Plan: Objective, Methods of jobevaluation, job evaluation procedure, merit rating (Performanceappraisal), method of merit rating, wage and wage incentive plans. **Inspection and Statistical Quality Control:** Inspection – functions, types, objectives and benefits, quality control principles, Concepts of quality circles, Total quality management, Quality assurance, Quality audit, Basic Concept ISO9000, ISO 14000 and QS 9000, Six sigma: Concept, Principle, Methodology, Scope, Advantage and limitations. SQC Concept, variable and attributes, normal distribution curves and its property charts for variable and attributes and their applications and interpretation (analysis) process capability. Acceptance sampling, sampling plans, OC curves and AOQ curves. **Workplace Accidents and Safety**: Accident Causation Theories (Dmino Theory, Human Factor Theory), Accident Investigation and Reporting. **Industrial Legislation:** Need for Industrial legislation, Factories act 1948, Industrial dispute act1947, The Indian trade unions act 1926, Industrial employment act 1946, Payment of wage act 1936, Workmen compensation act 1923, Payment of bonus act 1965, Employees provident fund scheme 1952. **Safety and Risk Management:** Safety Management Principles, Safety Program Plan, Safety Committees, Safety Performance Measures, Risk Assessment, Risk Management. **Safety Analysis Methods**: Failure Mode Effects Analysis (FMEA), Fault Tree analysis (FTA), Markov Method, Hazard and operability study (HAZOP), Job Hazard Analysis (JHA). **Human Factors in Safety:** Job Stress, Ergonomics, Human behavior, Human Reliability Prediction Models, Personal Protective Equipment, Safety Costing; Safety Cost Estimation Methods.
VII.	Course Outcome	Upon completion of the subject, students will be able to: 1. Understand the basic objectives, principles, techniques and safety measurements as well as various charts used inindustries. 2. Identify the selection criteria for the plant and its layout, different methods of work measurement and work sampling and hazards in the industries. 3. Analyse the various techniques to measure and improve the productivity with optimized cost and quality.

		4. Apply the knowledge of safety analysis methods such as FMEA, FTA, HAZOP etc. for accident avoidance and hazard/fault and cost estimation
VIII.	Textbooks/References	1. Manufacturing Organisation and Management, Harold Amrine, John Ritchey, Moodie, Kmec, 6th Ed., Pearson 2. Production System, Planning, Analysis and Control, J.L. Riggs 3rd ed. Wiley 3. Production and Operations Management, R. Panneerselvam, PHI Private Ltd., 4. Industrial Engineering and Production Management Martand Telsang S Chand &company. 5. Industrial Engineering and Production Management by Banga and Sharma, Khanna Publishers. 6. Industrial Engineering and Management, Dr. B.Kumar Khanna Publishers 7. Work study by International Labour Organisation, ILO 8. B. S. Dhillon, Engineering Safety: Fundamentals, Techniques, Applications, World Scientific, 2003. 9. H.E. Roland, B. Moriarty, System Safety Engineering and Management, John Wiley & Sons, 1990

I	Course Code	ME184002			
II	Course Title	**Robotics and Industrial Automation**			
III	Credit Structure	L	T	P	C
		3	1	2	5
IV	Prerequisite	Prerequisite: Kinematics of machine, Dynamics of machine, Basic knowledge of MATLAB			
V	Course Content	**Module 0: Preface**, Information for Students and Teachers **Module 1: Introduction** Introduction -- brief history, types, classification and usage, Science and Technology of robots, Textbooks and research journals, Artificial intelligence. **Module 2: Elements of robots -- joints, links, actuators** Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, Examples of D-H parameters and link transforms, different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Types of transmissions, Purpose of sensors, internal and external sensors, common sensors – encoders, tachometers, strain gauge basedforce-torque sensors, proximity and distance measuring sensors, and robotics vision. **Module 3: Kinematics of serial robots** Introduction, Direct and inverse kinematics problems, Examples of kinematics of common serial manipulators, workspace of a serial robot, Inverse kinematics of constrained and redundant robots, Tractrix based approach for fixed and free robots and multi-body systems, simulations and experiments, Solution procedures using theory of elimination. **Module 4: Velocity and statics of robot manipulators** Linear and angular velocity of links, Velocity propagation, Manipulator Jacobians for serial and parallel manipulators, Velocity ellipse and ellipsoids, Singularity analysis for serial manipulators, Loss and gain of degree of freedom, Statics of serial manipulators, Statics and force transformation matrix of a Gough-Stewart platform, Singularity analysis and statics. **Module 5: Dynamics of serial robots** Mass and inertia of links, Lagrangian formulation for equations of motion for serial and parallel manipulators, Generation of symbolic equations of motion using a computer, Simulation (direct and inverse) of dynamic equations of motion, Examples of a planar 2R and four-bar mechanism, Recursive dynamics. **Module 6: Modeling and Simulation of Robots** Computer vision, Models of links and joints, Kinematic modeling of multi-link robots, Dynamics and control of link manipulators, Numerical simulations results, Experiments with a planar two-link manipulator. Simulations using MATLAB.			

VI	Text/References	1. Introduction to Robotics. Front Cover. S. K. Saha. Tata McGraw Hill Education Private Limited, 2018. 2. Robot Dynamics and Control, Mark W. Spong, Seth Hutchinson, and M. Vidyasagar Second Edition 3. A Mathematical Introduction to Robotic Manipulation by Richard M. Murray, CRC Press

I	Course Code	ME 4501			
II	Course Title	B.Tech Project - I			
III	Credit Structure	L	T	P	C
		0	0	0	8
IV	Prerequisite	Nil			
V	Course Content	Students are required to carry out project under the supervision of faculty members for the defined objectives. The project includes the thesis submission and viva-voice.			
VI	Text/References				

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">ME 194001</td></tr>
<tr><td>II</td><td>Course Title</td><td colspan="4">Elective I Computational Methods for Mechanical Engineers</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV</td><td>Prerequisite</td><td colspan="4">Fluid Mechanics and Heat Transfer Fortran, Matlab or C Programming</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Mathematical Description of the Physical Phenomena Governing equations—mass, momentum, energy, species, General form of the scalar transport equation, Elliptic, parabolic and hyperbolic equations, Behavior of the scalar transport equation with respect to these equation type
Discretization Methods Methods for deriving discretization equations-finite difference, finite volume and finite element method, Method for solving discretization equations, Consistency, stability and convergence.
Diffusion Equation 1D-2D steady diffusion, Source terms, non-linearity, Boundary conditions, interface diffusion coefficient, under relaxation, Solution of linear equations (preliminary), Unsteady diffusion, Explicit, Implicit and Crank-Nicolson scheme, Two-dimensional conduction, Accuracy, stability and convergence revisited.
Convection and Diffusion Steady one-dimensional convection and diffusion, Upwind, exponential, hybrid, power, QUICK scheme, Two-dimensional convection-diffusion, Accuracy of Upwind scheme; false diffusion and dispersion, Boundary conditions
Introduction to FEM Basic finite element Concepts-Basic ideas in a finite element solution, General finite element solution procedure, Finite element equations using modified Galerkin method, Application: Axial
Two-dimensional FEM Isoperimetric quadrilateral Elements-Shape functions for rectangular elements, Isoperimetric mapping for quadrilateral elements, Numerical integration for quadrilateral elements, Four node quadrilateral element for 2D BVP, Eight node serendipity element for 2D BVP
Applications based on general two dimensional boundary value Problem-Ideal fluid flow around an irregular object, Two dimensional steady state heat flow
Plain Elasticity Two dimensional Elasticity-Governing differential equations, Constant strain triangular element, Four node quadrilateral element, Eight node isoperimetric element</td></tr>
<tr><td>VI</td><td>Text/References</td><td colspan="4">S. V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 1980.
D. A. Anderson, J. C. Tannehill, and R. H. Pletcher, Computational Fluid Mechanics and Heat Transfer,” Hemisphere Publishing Corpora- tion, 1984.
J. H. Ferziger and M. Peric, ”Computational Methods for Fluid Dynamics”, Second Edition, Springer, Berlin, 1999.
H. K. Versteeg and W. Malalasekera, ”An Introduction to Computational Fluid Dynamics: The Finite Volume Method”,</td></tr>
</table>

BACHELOR OF TECHNOLOGY

Mechanical and Aerospace Engineering Department
Semester - VIII

	Course Code	ME			
II	Course Title	B.Tech Project - II			
III	Credit Structure	L	T	P	C
		0	0	0	16
IV	Prerequisite(Ifanyfor the student)	Nil			
V	Course Content	Students are required to carry out project under the supervision of faculty members for the defined objectives. The project includes the thesis submission and viva-voice.			
VI	Text/References				

BACHELOR OF TECHNOLOGY
Mechanical and Aerospace Engineering Department

Minor Program in Drone Technology
Teaching Scheme

Course Code	Course Name	Lecture hours	Tutorial hours	Practical hours	Credit
AE 234001	Introduction to Drones	3	0	0	3
AE 234002	Dynamics and Control of Drones	3	0	0	3
AE 234003	Autonomous Navigation of Drones	3	0	0	3
AE 234004	Internet of Drones	3	0	0	3
AE 234005	Design, Development and Testing of Drones	0	1	6	4
	Total	12	1	6	16

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">AE 234001</td></tr>
<tr><td>II</td><td>Title of the course</td><td colspan="4">Introduction to Drones</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV</td><td>Exposure</td><td colspan="4">Fundamentals of drone technology, including aerodynamics, power systems, and flight controls.</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">History of Drones, Classification, Basics of Aerodynamics, Flight Mechanics, Propulsion system, Structures and materials of Drones, DGCA Drone rules.</td></tr>
<tr><td>VI</td><td>Text/Reference Books</td><td colspan="4">Fahlstrom, Paul, and Thomas Gleason. Introduction to UAV systems. John Wiley & Sons, 2012.
Austin, Reg. Unmanned aircraft systems: UAVs design, development and deployment. Vol. 54. John Wiley & Sons, 2011.
Filippone, Antonio. Flight performance of fixed and rotary wing aircraft. Elsevier, 2006.
Anderson, John David, and Mary L. Bowden. "Introduction to flight." 2005.</td></tr>
</table>

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">AE 234002</td></tr>
<tr><td>II</td><td>Title of the course</td><td colspan="4">Dynamics and Control of Drones</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV</td><td>Exposure</td><td colspan="4">Fundamentals of drone technology, including aerodynamics, power systems, and flight controls.</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Fundamentals of drone dynamics, modeling and simulation of drone motion and stability, Flight control systems, including control laws and control allocation.</td></tr>
<tr><td>VI</td><td>Text/Reference Books</td><td colspan="4">1. Probabilistic Robotics by Sebastian Thrun, Wolfram Burgard and Dieter Fox, MIT Press, 2005.
2. Small Unmanned Aircraft: Theory and Practice, Randal W. Beard, Timothy W. McLain, Princeton University Press, 2012.
3. Multicopter Design and Control Practice, Q. Quan, Springer, 2020.</td></tr>
</table>

<table>
<tr><td>I</td><td>Course Code</td><td colspan="4">AE 234003</td></tr>
<tr><td>II</td><td>Title of the course</td><td colspan="4">Autonomous Navigation of Drones</td></tr>
<tr><td rowspan="2">III</td><td rowspan="2">Credit Structure</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>IV</td><td>Exposure</td><td colspan="4">Fundamentals of drone technology, including aerodynamics, power systems, and flight controls.</td></tr>
<tr><td>V</td><td>Course Content</td><td colspan="4">Introduction to autonomous drone navigation and its applications, Fundamentals of drone sensors, including vision, lidar, and GPS, Mapping and localization, including SLAM (Simultaneous Localization and Mapping) and Kalman filtering, Trajectory planning and control, including path generation, obstacle avoidance, and tracking control.</td></tr>
<tr><td>VI</td><td>Text/Reference Books</td><td colspan="4">Probabilistic Robotics by Sebastian Thrun, Wolfram Burgard and Dieter Fox, MIT Press, 2005.
Small Unmanned Aircraft: Theory and Practice, Randal W. Beard, Timothy W. McLain, Princeton University Press, 2012.
Multicopter Design and Control Practice, Q. Quan, Springer, 2020.</td></tr>
</table>

I	Course Code	**AE 234004**			
II	Title of the course	**Internet of Drones**			
III	Credit Structure	L	T	P	C
		3	0	0	3
IV	Exposure	Fundamentals of drone technology, including aerodynamics, power systems, and flight controls.			
V	Course Content	Drone Communication Protocols and Network Topologies, The Role of Artificial Intelligence in the Internet of Drones, Drone Security and Privacy Concerns, Applications of the Internet of Drones in Agriculture, Disaster Response and Search and Rescue, Drone Delivery and Logistics, The Future of the Internet of Dro			
VI	Text/Reference Books	1. Fahlstrom, Paul, and Thomas Gleason. Introduction to UAV systems. John Wiley & Sons, 2012. 2. Austin, Reg. Unmanned aircraft systems: UAVs design, development and deployment. Vol. 54. John Wiley & Sons, 2011. 3. Filippone, Antonio. Flight performance of fixed and rotary wing aircraft. Elsevier, 2006. 4. Anderson, John David, and Mary L. Bowden. "Introduction to flight." 2005.			

I	Course Code	**AE 234005**			
II	Title of the course	**Design, Development and Testing of Drones**			
III	Credit Structure	L	T	P	C
		0	1	6	4
IV	Exposure	Fundamentals of drone technology, including aerodynamics, power systems, and flight controls.			
V	Course Content	Design methodology of Drones, Safety considerations and regulations for drone design and testing, Drone testing and validation including ground and flight testing, and data analysis.			
VI	Text/Reference Books	1. Fahlstrom, Paul, and Thomas Gleason. Introduction to UAV systems. John Wiley & Sons, 2012. 2. Austin, Reg. Unmanned aircraft systems: UAVs design, development and deployment. Vol. 54. John Wiley & Sons, 2011. 3. Filippone, Antonio. Flight performance of fixed and rotary wing aircraft. Elsevier, 2006. 4. Anderson, John David, and Mary L. Bowden. "Introduction to flight." 2005.			