JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech. in AERONAUTICAL ENGINEERING
COURSE STRUCTURE & SYLLABUS (R18)

Applicable From 2018-19 Admitted Batch

I YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	MA101BS	Mathematics - I	3	1	0	4
2	PH102BS	Engineering Physics	3	1	0	4
3	CS103ES	Programming for Problem Solving	3	1	0	4
4	ME104ES	Engineering Graphics	1	0	4	3
5	PH105BS	Engineering Physics Lab	0	0	3	1.5
6	CS106ES	Programming for Problem Solving Lab	0	0	3	1.5
7	*MC109ES	Environmental Science	3	0	0	0
		Induction Programme				
		Total Credits	**13**	**3**	**10**	**18**

I YEAR II SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	MA201BS	Mathematics - II	3	1	0	4
2	CH202BS	Chemistry	3	1	0	4
3	ME203ES	Engineering Mechanics	3	1	0	4
4	ME205ES	Engineering Workshop	1	0	3	2.5
5	EN205HS	English	2	0	0	2
6	CH206BS	Engineering Chemistry Lab	0	0	3	1.5
7	EN207HS	English Language and Communication Skills Lab	0	0	2	1
		Total Credits	**12**	**3**	**8**	**19.0**

II YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	MA301BS	Probability and Statistics & Complex Variables	3	1	0	4
2	EE300ES	Basic Electrical and Electronics Engineering	3	0	0	3
3	AE303PC	Theory of Structures	3	0	0	3
4	AE304PC	Fluid Mechanics and Hydraulics	3	0	0	3
5	AE305PC	Aerodynamics - I	3	1	0	4
6	AE306PC	Mechanics of Solids Lab	0	0	2	1
7	AE307PC	Fluid Mechanics and Hydraulics Lab	0	0	4	2
8	EE309PC	Basic Electrical and Electronics Engineering Lab	0	0	2	1
9	*MC309	Constitution of India	3	0	0	0
		Total Credits	**18**	**2**	**8**	**21**

II YEAR II SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	AE401ES	Probability Distributions and Numerical Methods	3	1	0	4
2	AE402PC	Low Speed Aerodynamics	3	0	0	3
3	AE403PC	Aircraft Materials and Production	3	1	0	4
4	AE404PC	Analysis of Aircraft Structures	3	1	0	4
5	AE405PC	Aero-Thermodynamics	3	0	0	3

6	AE406ES	Aerodynamics Lab	0	0	2	1
7	AE407PC	Aerospace Structures Lab	0	0	2	1
8	AE408PC	Aircraft Materials and Production Lab	0	0	2	1
10	*MC409	Gender Sensitization Lab	0	0	2	0
		Total Credits	**15**	**3**	**8**	**21**

III YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	AE501PC	Aircraft Propulsion	3	1	0	4
2	AE502PC	High Speed Aerodynamics	3	0	0	3
3	AE503PC	Finite Element Methods	3	0	0	3
4	SM504MS	Business Economics and Financial Analysis	3	0	0	3
5	AE505PC	Aircraft Systems and Controls	3	0	0	3
6	AE506PC	Aircraft Performance and Stability	3	0	0	3
7	AE507PC	Computer Aided Aircraft Engineering Drawing	0	0	2	1
8	AE508PC	Flight Control Lab	0	0	2	1
9	AE509PC	Aircraft Propulsion Lab	0	0	2	1
10	*MC510	Intellectual Property Rights	3	0	0	0
		Total Credits	**21**	**1**	**6**	**22**

III YEAR II SEMESTER

S. No	Course Code	Course Title	L	T	P	Credits
1	AE601PC	Space Propulsion	3	0	0	3
2	AE602PC	Computational Aerodynamics	3	1	0	4
3	AE603PC	Helicopter Aerodynamics	3	0	0	3
4		Professional Elective - I	3	0	0	3
5		Open Elective - I	3	0	0	3
6	AE604PC	Aircraft Design	3	0	0	3
7	AE605PC	Aerospace Propulsion Lab	0	0	2	1
8	AE606PC	CFD Lab	0	0	2	1
9	EN608HS	Advanced Communication Skills Lab	0	0	2	1
10	*MC609	Environmental Science	3	0	0	0
		Total Credits	**21**	**1**	**6**	**22**

IV YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	AE701PC	Vibration and Aero-elasticity	3	0	0	3
2		Professional Elective – II	3	0	0	3
3		Professional Elective – III	3	0	0	3
4		Professional Elective - IV	3	0	0	3
5		Open Elective - II	3	0	0	3
6	AE702PC	Industrial Oriented Mini Project/ Summer Internship	0	0	0	2*
7	AE703PC	Seminar	0	0	2	1
8	AE704PC	Project Stage - I	0	0	6	3
		Total Credits	**15**	**0**	**8**	**21**

IV YEAR II SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1		Professional Elective – V	3	0	0	3
2		Professional Elective - VI	3	0	0	3
3		Open Elective - III	3	0	0	3
4	AE801PC	Project Stage - II	0	0	14	7
		Total Credits	**9**	**0**	**14**	**16**

Professional Elective – I

AE611PE	Advanced Solid Mechanics
AE612PE	Design and Analysis of Composite Structures
AE613PE	Unmanned Air Vehicles

Professional Elective – II

AE711PE	Space Mechanics
AE712PE	Rockets and Missiles
AE713PE	Wind Tunnel Technique

Professional Elective – III

AE721PE	Experimental Aerodynamics
AE722PE	Hypersonic Aerodynamics
AE723PE	Advanced Computational Aerodynamics

Professional Elective – IV

AE731PE	Industrial Aerodynamics
ME732PE	Turbo Machinery
AE733PE	Theory of Combustion

Professional Elective – V

AE811PE	Heat Transfer
AE812PE	Cryogenics
AE813PE	Aero Engine Design

Professional Elective – VI

AE821PE	Precision Engineering
AE822PE	Practical Non-Destructive Testing
AE823PE	CAD/CIM

***MC - Environmental Science – Should be Registered by Lateral Entry Students Only.**
***MC – Satisfactory/Unsatisfactory**

Note: Industrial Oriented Mini Project/ Summer Internship is to be carried out during the summer vacation between 6th and 7th semesters. Students should submit report of Industrial Oriented Mini Project/ Summer Internship for evaluation.

AE701PC: VIBRATION AND AERO-ELASTICITY

B.Tech. IV Year AE I Sem.	L	T/P/D	C
	3	0/0/0	3

Course Objectives: Nil

- Know the concepts of vibration and single degree of freedom systems.
- Analyze the two Degree and Multi degree of Freedom Systems.
- Understand the interaction among the aerodynamic, elastic and inertia forces.

Course Outcomes:

- To study the dynamic behavior of different aircraft components and the interaction among the aerodynamic, elastic and inertia forces.

UNIT I

Basic Motions: Simple harmonic motion – Terminologies – Newton's Law – D' Alembert's principle – Energy Methods

UNIT II

Single Degree of Freedom Systems: Free vibrations – Damped vibrations – Forced Vibrations, with and without damping –support excitation – Vibration measuring instruments.

UNIT III

Multi Degree of Freedom Systems: Two degrees of freedom systems – Static and Dynamic couplings vibration absorber-Principal co- ordinates, Principal modes and orthogonal condition – Eigen value problems. Hamilton's principle-Lagrangean equation and application – Vibration of elastic bodies-Vibration of strings- Longitudinal, Lateral and Torsional vibrations.

UNIT IV

Approximate Methods: Rayleigh's and Holzer Methods to find natural frequencies.

UNIT V

Elements of Aeroelasticity: Aeroelastic problems-collar's triangle of forces-wing divergence-aileron control reversal-flutter.

TEXT BOOKS

1. Timoshenko S., "Vibration Problems in Engineering"– John Wiley and Sons,New York, 1993.
2. Fung Y.C., "An Introduction to the Theory of Aero elasticity" – John Wiley & Sons, New York, 1995.

REFERENCE BOOKS

1. Bisplinghoff R.L., Ashley H and Hoffman R.L., "Aero elasticity" – Addision Wesley Publication, New York, 1983.
2. Tse. F.S., Morse, I.F., Hinkle, R.T., "Mechanical Vibrations", – Prentice Hall, New York, 1984.
3. Scanlan R.H. & Rosenbaum R., "Introduction to the study of Aircraft Vibration & Flutter", John Wiley and Sons. New York, 1982.
4. Tongue. B. H., "Principles of Vibration", Oxford University Press, 2000.

AE711PE: SPACE MECHANICS (PE – II)

B.Tech. IV Year AE I Sem.	L	T/P/D	C
	3	0/0/0	3

Course Objectives:

- Impart the knowledge in two-body, restricted three-body and n-body problem, Hamiltonian dynamics, canonical transformations, Poincare surface sections.
- Analyze the basic Newtonian dynamics and spacecraft altitude dynamics.
- Provide necessary knowledge to study the satellite and interplanetary trajectories and Formal approaches for handling coordinate transformations.
- Solve the orbital problems related to Earth satellite orbits using Hamilton‘s and generate interplanetary orbits in the frame work of restricted three-body problem.

Course Outcomes:

- Solar Systems and various coordinate systems
- Effect of perturbation on satellite
- Satellite orbits
- Missile trajectory

UNIT-I

Introduction to Space Mechanics: Basic concepts: The solar system, Reference frames and coordinate systems, The celestial sphere, The ecliptic, Motion of vernal equinox, Sidereal time, Solar Time, Standard Time, The earth‘s atmosphere. The many body problem, Lagrange-Jacobi identity. The circular restricted three body problem, Libration points, Relative Motion in the N-body problem.

UNIT-II

The Two Body Problem: Equations of motion-General characteristics of motion for different orbits-Relations between position and time for different orbits, Expansions in elliptic motion, Orbital Elements. Relation between orbital elements and position and velocity: Launch vehicle ascent trajectories, General aspects of satellite injection. Dependence of orbital parameters on in-plane injection parameters, Launch vehicle performances, Orbit deviations due to injection errors.

UNIT-III

Perturbed Satellite Orbit: Special and general perturbations- Cowell‘s Method, Encke‘s method. Method of variations of orbital elements, General perturbations approach. Two-dimensional interplanetary trajectories, Fast interplanetary trajectories, Three dimensional interplanetary trajectories. Launch of interplanetary spacecraft. Trajectory about the target planet.

UNIT-IV

Ballistic Missile Trajectories: The boost phase, the ballistic phase, Trajectory geometry, optimal flights. Time of flight, Re-entry phase. The position of the impact point, Influence coefficients.

UNIT-V

Low-Thrust Trajectories: Equations of Motion. Constant radial thrust acceleration, Constant tangential thrust (Characteristics of the motion), Linearization of the equations of motion, Performance analysis.

TEXT BOOKS:

1. J. W. Cornelisse, —Rocket Propulsion and Spaceflight Dynamics‖, Pitman Publishing, London, 1979.
2. William E. Wiesel, —Spaceflight Dynamics‖, McGraw-Hill, 3rd Edition, New Delhi, 2010.

REFERENCE BOOKS:

1. Vladimir A. Chobotov, —Orbital Mechanics‖, AIAA Education Series, USA, 3rd Edition, 2002.
2. Kaplan, Marshall H., —Modern Spacecraft Dynamics and Control‖, John Wiley & Sons, New York, 1976.
3. Wiesel, William E., —Spaceflight Dynamics‖, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2nd Edition 2007.
4. David A. Vellado, —Fundamentals of Astrodynamics and Applications‖, Springer, Germany, 3rd Edition, 2007.

AE712PE: ROCKETS AND MISSILES (PE – II)

B.Tech. IV Year AE I Sem.	L	T/P/D	C
	3	0/0/0	3

Course Objectives

- To compute and analyze the various forces and moments acting on a rocket
- To formulate the equations of motions for flight and separation phases
- To understand the combustion and propulsion systems in rocket
- To select suitable materials for the rockets and missiles
- To understand the design, performance and testing aspects

Course Outcomes:

- To provide the design basics of rockets and missiles, their construction and functions
- To focus on design principles, performance, materials selection and testing of rockets and missiles
- To understand aerodynamics, flight dynamics, optimization of performance of multi-stage rockets and separation dynamics of rockets and missiles

UNIT I

Rocket Dynamics: Classification of launch vehicles and missiles – Rocket systems - Airframe components - Forces and moments acting on a rocket – Propulsion, aerodynamics, gravity – inertial and non-inertial frames - coordinate transformation – Equations of motion for three-dimensional motion through atmosphere and vacuum, earth's atmosphere, numerical problems

UNIT II

Solid Propulsion and Pyrotechnics: Solid propellant rockets - classification, components and their design considerations, propellant grain design - grain mechanical properties, ballistics and burn rate design issues - igniter design - types of nozzles and thrust vector control, pyrotechnic devices and systems-classification, mechanisms and application of pyrotechnic devices in rockets and missiles. Design problems in rocket systems.

UNIT III

Liquid Propulsion and Control Systems: Liquid propellant rockets – classification and components - thrust chamber, feed systems, propellant tanks, turbo-pumps, types of valves and applications- their design considerations. Different bipropellant systems like cryogenics and their characteristics, pogo and slooh engine gimbal systems and thrusters for control. Spacecraft propulsion and control systems-Design problems.

UNIT IV

Multi-Staging of Rocket and Separation Dynamics: Navigation and guidance systems in rockets and missiles - aerodynamic control systems of missiles- multi-staging of rockets - vehicle optimization techniques -stage separation system – dynamics, separation techniques - rocket flight dispersion, numerical problems.

UNIT V

Design, Materials and Testing of Rockets: Design requirements and selection, performance evaluation and assessment, space environment on the selection of materials for rockets and spacecraft, material selection for specific requirements, advance materials-super alloys and composite materials. Qualification of rocket and missile systems, types of testing and evaluation of design and function.

TEXT BOOKS:

1. Ramamurthi.K.: Rocket Propulsion. Macmillan Publishers India first edition. 2010.

2. Sutton.G.P. and Biblarz.O: Rocket Propulsion Elements. 7th edition. Wiley India Pvt Ltd. 2010.
3. Cornelisse, J.W, Schoyer H F R, and Wakker K F, "Rocket Propulsion and Space Dynamic", Pitman Publishing Co., 1979.

REFERENCE BOOKS:

1. Ronald Humble, Henry and Larson.Space Propulsion Analysis and Design. Mc Graw-Hill. 1995
2. George M. Siouris, Missile Guidance and Control Systems, Springer-Verlag New York, 2000.

AE713PE: WIND TUNNEL TECHNIQUE (PE – II)

B.Tech. IV Year AE I Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Pre-Requisites: Aerodynamics

Course Objectives:

- The students are exposed to various types and techniques of Aerodynamic data generation on aerospace vehicle configurations in the aerospace industry.

Course Outcomes:

- Ability to use various techniques of Aerodynamic data generation

UNIT I

Principles of Model Testing: Buckingham Theorem – Non dimensional numbers – Scale effect – Geometric Kinematic and Dynamic similarities.

UNIT II

Types and Functions of Wind Tunnels: Classification and types – special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions – Layouts – sizing and design parameters.

UNIT III

Calibration of Wind Tunnels: Test section speed – Horizontal buoyancy – Flow angularities – Flow uniformity & turbulence measurements – Associated instrumentation – Calibration of subsonic & supersonic tunnels.

UNIT IV

Conventional Measurement Techniques: Force measurements and measuring systems – Multi component internal and external balances –Pressure measurement system - Steady and Unsteady Pressure- single and multiple measurements - Velocity measurements – Intrusive and Non-intrusive methods – Flow visualization techniques surface flow, oil and tuft - flow field visualization, smoke and other optical and nonintrusive techniques

UNIT V

Special Wind Tunnel Techniques: Intake tests – store carriage and separation tests - Unsteady force and pressure measurements –wind tunnel model design

TEXT BOOKS:

1. Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing", John Wiley Publication, 1984.
2. NAL-UNI Lecture Series 12:" Experimental Aerodynamics", NAL SP 98 01 April 1998.

REFERENCE BOOKS:

1. Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.
2. Bradsaw "Experimental Fluid Mechanics".
3. Short term course on Flow visualization techniques, NAL , 2009
4. Lecture course on Advanced Flow diagnostic techniques 17-19 September 2008 NAL, Bangalore.

AE721PE: EXPERIMENTAL AERODYNAMICS (PE – III)

B.Tech. IV Year AE I Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Pre-Requisites: Aerodynamics

Course Objectives:

- To provide details, operating principles and limitations of forces, pressure, velocity and temperature measurements. To describe flow visualization techniques and to highlight in depth discussion of Analog methods.

Course Outcomes:

- Knowledge on measurement techniques in aerodynamic flow.
- Acquiring basics of wind tunnel measurement systems
- Specific instruments for flow parameter measurement like pressure, velocity, temperature etc.

UNIT I

Basic Measurements in Fluid Mechanics: Objective of experimental studies – Fluid mechanics measurements – Properties of fluids – Measuring instruments – Performance terms associated with measurement systems – Direct measurements - Analogue methods – Flow visualization –Components of measuring systems – Importance of model studies.

UNIT II

Characteristics of Measurements: Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels - Power losses in a wind tunnel – Instrumentation of wind tunnels – Turbulence- Wind tunnel balance –principles, types and classifications -Balance calibration.

UNIT III

Flow Visualization and Analogue Methods: Principles of Flow Visualization – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Schlieren system – Shadowgraph - Hydraulic analogy – Hydraulic jumps – Electrolytic tank

UNIT IV

Pressure, Velocity and Temperature Measurements: Measurement of static and total pressures in low and high-speed flows- Pitot-Static tube characteristics - Pressure transducers – principle and operation – Velocity measurements - Hot-wire anemometry – LDV – PIV: Temperature measurements.

UNIT V

Special Flows and Uncertainty Analysis: Experiments on Taylor-Proudman theorem and Ekman layer – Measurements in boundary layers - Data acquisition and processing – Signal conditioning - Uncertainty analysis – Estimation of measurement errors – External estimate of the error – Internal estimate of the error – Uncertainty calculation - Uses of uncertainty analysis.

TEXT BOOKS:

1. Rathakrishnan, E., “Instrumentation, Measurements, and Experiments in Fluids,” CRC Press –Taylor & Francis, 2007.
2. Robert B Northrop, “Introduction to Instrumentation and Measurements”, Second Edition, CRC Press, Taylor & Francis, 2006.

REFERENCE BOOKS:

1. Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.Bradsaw Experimental Fluid Mechanics.
2. NAL-UNI Lecture Series 12: Experimental Aerodynamics, NAL SP 98 01 April 1998
3. Lecture course on "Advanced Flow diagnostic techniques" 17-19 September 2008 NAL, Bangalore

AE722PE: HYPERSONIC AERODYNAMICS (PE – III)

B.Tech. IV Year AE I Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Pre-Requisites: High Speed Aerodynamics

Course Objectives:

- Knowledge in basics of hypersonic and supersonic aerodynamics
- Acquiring knowledge in theory of hypersonic flow.
- Understanding of boundary layers of hypersonic flow and viscous interaction
- Role of chemical and temperature effects in hypersonic flow.

Course Outcomes:

- To introduce fundamental concepts and features peculiar to hypersonic flow to students to familiarize them with the aerodynamical aspects of hypersonic vehicles and the general hypersonic flow theory.

UNIT I

Fundamentals Of Hypersonic Aerodynamics: Introduction to hypersonic aerodynamics – differences between hypersonic aerodynamics and supersonic aerodynamics - concept of thin shock layers and entropy layers – hypersonic flight paths – hypersonic similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT II

Simple Solution Methods For Hypersonic Inviscid Flows: Local surface inclination methods – Newtonian theory – modified Newtonian law – tangent wedge and tangent cone and shock expansion methods – approximate methods - hypersonic small disturbance theory – thin shock layer theory.

UNIT III

Viscous Hypersonic Flow Theory: Boundary layer equations for hypersonic flow – hypersonic boundary layers – self similar and non self-similar boundary layers – solution methods for non self similar boundary layers – aerodynamic heating and its adverse effects on airframe.

UNIT IV

Viscous Interactions In Hypersonic Flows: Introduction to the concept of viscous interaction in hypersonic flows - Strong and weak viscous interactions - hypersonic viscous interaction similarity parameter – introduction to shock wave boundary layer interactions.

UNIT V

high temperature effects in hypersonic flows: Nature of high temperature flows – chemical effects in air – real and perfect gases – Gibb's free energy and entropy - chemically reacting boundary layers – recombination and dissociation.

TEXT BOOKS:

1. John D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", McGraw hill Series,New York, 1996.

REFERENCE BOOKS:

1. John D. Anderson. Jr., "Modern Compressible flow with historical Perspective", McGraw Hill Publishing Company, New York, 1996.
2. John T. Bertin, "Hypersonic Aerothermodynamics", published by AIAA Inc., Washington. D.C., 1994

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AE723PE: ADVANCED COMPUTATIONAL AERODYNAMICS (PE – III)

B.Tech. IV Year AE I Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Pre-Requisites: CFD

Course Objectives:

- Explain the concept of panel methods, analyze various boundary conditions applied and demonstrate several searching and sorting algorithms.
- Describe the initial methods applied in the process of CFD tools development their advantages and disadvantages over modern developed methods.
- Demonstrate different methods evolved in analyzing numerical stability of solutions and evaluate the parameters over which the stability depends and their range of values.
- Understand advanced techniques and methods in time marching steps and identify different boundary conditions for different cases in CFD techniques.

Course Outcomes:

- Different techniques to solve the complex fluid dynamics problem numerically

UNIT - I

Numerical Solutions: Euler equations: Flux approach, Lax-Wendroff method, basic principles of upwind schemes, flux vector splitting, Steger Warming flux vector splitting, Van Leer flux vector splitting, Upwind reconstruction, evolution, Godunov‘s first order upwind method, Roe‘s first order upwind method.

UNIT- II

Time Dependent Methods: Stability of solution, explicit methods, FTFS, FTCS, FTBS, Leapfrog method, Lax method. Implicit methods: Euler‘s FTCS, Crank Nicolson method, description of Lax-Wendroff scheme, McCormack two step predictor-corrector method, description of time split methods, approximate factorization schemes.

UNIT- III

Boundary Conditions: Boundary Layer Equations: Setting up the boundary layer equations, flat plate boundary layer solution, boundary layer transformations, explicit and implicit discretization, solution of the implicit difference equations, integration of the continuity equation, boundary layer edge and wall shear stress, Keller-box scheme. Concept of dummy cells, solid wall inviscid flow, viscous flow, farfield concept of characteristic variables, modifications for lifting bodies inlet outlet boundary, injection boundary, symmetry plane, coordinate cut, periodic boundaries, interface between grid blocks, flow gradients at boundaries of unstructured grids.

UNIT- IV

Method of Characteristics: Philosophy of method of characteristics, determination of characteristic lines, two dimensional irrotational flow, determination of compatibility equations, unit processes, supersonic nozzle design by the method of characteristics, supersonic wind tunnel nozzle, minimum length nozzles, domain of dependence and range of influence.

UNIT- V

Panel Methods: Basic formulation, boundary conditions, physical considerations, reduction of a problem to a set of linear algebraic equations, aerodynamic loads, preliminary considerations prior to establishing numerical solution, steps toward constructing a numerical solution, solution of thin airfoil with lumped vortex filament, accounting for effects of compressibility and viscosity.

TEXT BOOKS:

1. Tannehill John C, Anderson Dale A, Pletcher Richard H, ―Computational Fluid Mechanics and Heat Transfer‖, Taylor & Francis, 2nd Edition, 1997.
2. Chung T G, ―Computational Fluid Dynamics‖, Cambridge University Press, 2nd Edition, 2010.
3. Katz Joseph and Plotkin Allen, ―Low-Speed Aerodynamics‖, Cambridge University Press, 2nd Edition, 2006.

REFERENCE BOOKS:

1. Anderson J D, ―Modern Compressible Fluid Flow‖, 2nd Edition, McGraw Hill, 1990.
2. Anderson J D, ―Fundamentals of Aerodynamics‖, Tata McGraw Hill, 5th Edition, 2010.
3. Anderson J D, ―Computational Fluid Dynamics‖, McGraw Hill, 1995.

AE731PE: INDUSTRIAL AERODYNAMICS (PE – IV)

B.Tech. IV Year AE I Sem.	L	T/P/D	C
	3	0/0/0	3

Pre-Requisites: Low speed Aerodynamics

Course Objectives:

- To familiarize the learner with non-aeronautical uses of aerodynamics such as road vehicle, building aerodynamics and problems of flow induced vibrations.

Course Outcomes:

- Use of aerodynamics for non- aerodynamics such as vehicle, building
- Solve the problems and able to analyse vibrations during flow

UNIT I

Atmosphere: Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows.

UNIT II

Wind Energy Collectors: Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.

UNIT III

Vehicle Aerodynamics: Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft.

UNIT IV

Building Aerodynamics: Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, Building codes, Building ventilation and architectural aerodynamics.

UNIT V

Flow Induced Vibrations: Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.

TEXT BOOKS:

1. M. Sovran (Ed), “Aerodynamics and drag mechanisms of bluff bodies and Road vehicles”, Plenum press, New York, 1978.
2. Sachs. P., “Winds forces in Engineering”, Pergamon Press, 1978.

REFERENCE BOOKS:

1. Blevins. R.D., “Flow Induced Vibrations”, Van Nostrand, 1990.
2. Calvent. N.G., “Wind Power Principles”, Charles Griffin & Co., London, 1979

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ME732PE: TURBO MACHINERY (PE – IV)

B.Tech. IV Year AE I Sem.	L	T/P/D	C
	3	0/0/0	3

Pre-requisites: Thermal Engineering, Heat Transfer

Course Objectives:

- Provide students with opportunities to apply basic flow equations
- Train the students to acquire the knowledge and skill of analyzing different turbo machines.
- How to compare and chose machines for various operations

Course Outcomes:

- Ability to design and calculate different parameters for turbo machines
- Prerequisite to CFD and Industrial fluid power courses
- Ability to formulate design criteria
- Ability to understand thermodynamics and kinematics behind turbo machines

UNIT - I

Introduction to Turbomachinery: Classification of turbo-machines, second law of thermodynamics applied to turbine and compressors work, nozzle, diffuser work, fluid equation, continuity, Euler‘s, Bernoulli‘s, equation and its applications, expansion and compression process, reheat factor, preheat factor

UNIT - II

Fundamental Concepts of Axial and Radial Machines: Euler‘s equation of energy transfer, vane congruent flow, influence of relative circulation, thickness of vanes, number of vanes on velocity triangles, slip factor, Stodola, Stanitz and Balje‘s slip factor, suction pressure and net positive suction head, phenomena of cavitation in pumps, concept of specific speed, shape number, axial, radial and mixed flow machines, similarity laws.

UNIT - III

Gas Dynamics: Fundamental thermodynamic concepts, isentropic conditions, mach numbers, and area, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas. Supersonic flow, oblique shock waves. Normal shock recoveries, detached shocks, Aerofoil theory.

Centrifugal compressor: Types, Velocity triangles and efficiencies, Blade passage design, Diffuser and pressure recovery. Slip factor, Stanitz and Stodolas formula's, Effect of inlet mach numbers, Pre whirl, Performance

UNIT - IV

Axial Flow Compressors: Flow Analysis, Work, and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Degree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance

Cascade Analysis: Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

UNIT - V

Axial Flow Gas Turbines: Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Zweifels relation, Design cascade analysis, Soderberg, Hawthrone, Ainley, Correlations, Secondary flow, Free vortex blade, Blade angles for variable degree of reaction. Actuator disc, Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, off design performance.

TEXT BOOKS:

1. Principles of Turbo Machines/DG Shepherd / Macmillan
2. Turbines, Pumps, Compressors/Yahya/ Mc Graw Hill

REFERENCE BOOKS:

1. A Treatise on Turbo machines / G. Gopal Krishnan *and* D. Prithviraj/ SciTech
2. Gas Turbine Theory/ Saravanamuttoo/ Pearson
3. Turbo Machines/ A Valan Arasu/ Vikas Publishing House Pvt. Ltd.

AE733PE: THEORY OF COMBUSTION (PE – IV)

B.Tech. IV Year AE I Sem.	L	T/P/D	C
	3	0/0/0	3

Pre-Requisites: Nil

Course Objectives:

- Understand the concepts in combustion theory and illustrate students involved in combustion research with the required fundamental knowledge in combustion stoichiometry.
- Familiarize in the area of combustion in various engines, generalise stability limits and flame stabilization in diffusion flame.
- Calculate the combustion efficiency. Discuss fundamental combustion problems arising from gas turbine combustion or more generally from combustion in steady flowing premixed systems.
- Determine the supersonic combustion. Combustion in rocket engines and emission. Different types of combustion chambers in gas-turbine engines, primary requirements of the combustor, afterburners.

Course Outcomes:

- To familiarize the students in the area of combustion in various engines.

UNIT-I

Basics Of Combustion Theory: Combustion stoichiometry and thermo chemical calculation, chemical kinetics and equilibrium, transport phenomena, theory of viscosity, conductivity and diffusivity.

UNIT-II

Pre-Mixed Flames: Description of premixed flames, burning velocity and parametric dependences, experimental methods of measuring burning velocity, simple one-dimensional thermal theory of flame, concepts of minimum ignition energy, quenching distance, stability limits and flame stabilization.

UNIT-III

Diffusion Flame: Jet flame physical description, theoretical analysis-Burke-Schumann‘s analysis, mechanism of soot formation, Defining of premixed, diffusion flames, liquid fuel combustion flames. Liquid fuel combustion, difference between premixed and diffusion flames, liquid fuel combustion-conservation equations, calculation of mass burning rate, droplet burning.

UNIT-IV

Combustion In Reciprocating And Gas- Turbine Engines: Description of the combustion process in piston engines, Combustion efficiency and factors affecting it, Rankine - Hugoniot curves, deflagration and detonation in reciprocating engines and preventive methods; Description of different types of combustion chambers in gas-turbine engines, primary requirements of the combustor, afterburners.

UNIT-V

Combustion In Rocket Engines And Emission: Types of rockets based on combustion, solid fuel combustion, combustion of carbon particle, simplified analysis, boundary layer combustion, combustion of carbon sphere with co burning gas phase; Chemical emission from combustion and its effects, exhaust gas analysis, emission control.

TEXT BOOKS:

1. Stephen R Turns, —An Introduction to combustion Concepts and Application‖, TMH Publication, 3rd Edition, 2011.
2. Fawzy El-Mahallawy, Saad El-Din Habik, Elsevier —Fundamentals and Technology of combustion‖, 1st Edition, 2002.

REFERENCE BOOKS:

1. Charles E. Baukal, —Heat Transfer in Industrial Combustion‖, CRC Press, 1st Edition, 2000.
2. G. Singer, —Combustion, Fossil Power Systems‖ Ed Publications, 4th Edition, 1966.
3. S. P. Sharma, Chandra Mohan —Fuels and Combustion‖, Tata McGraw Hill Publishing Co., 1st Edition, 1987.

AE811PE: HEAT TRANSFER (PE – V)

B.Tech. IV Year AE II Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Note: Heat Transfer Data Book is permitted.

Pre-requisite: Thermodynamics

Course Objectives: To provide knowledge about application of conduction, convection and radiation heat transfer concepts to different practical applications

Course Outcome: At the end of this course, student will be able to

- Understand the basic modes of heat transfer
- Compute one dimensional steady state heat transfer with and without heat generation
- Understand and analyze heat transfer through extended surfaces
- Understand one dimensional transient conduction heat transfer
- Understand concepts of continuity, momentum and energy equations
- Interpret and analyze forced and free convective heat transfer
- Understand the principles of boiling, condensation and radiation heat transfer
- Design of heat exchangers using LMTD and NTU methods

UNIT – I

Introduction: Modes and mechanisms of heat transfer – Basic laws of heat transfer –General discussion about applications of heat transfer.

Conduction Heat Transfer: Fourier rate equation – General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates – simplification and forms of the field equation – steady, unsteady, and periodic heat transfer – Initial and boundary conditions

One Dimensional Steady State Conduction Heat Transfer: Homogeneous slabs, hollow cylinders, and spheres- Composite systems– overall heat transfer coefficient – Electrical analogy – Critical radius of insulation

UNIT – II

One Dimensional Steady State Conduction Heat Transfer: Variable Thermal conductivity – systems with heat sources or Heat generation-Extended surface (fins) Heat Transfer – Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature

One Dimensional Transient Conduction Heat Transfer: Systems with negligible internal resistance – Significance of Biot and Fourier Numbers –Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi infinite body.

UNIT – III

Convective Heat Transfer: Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation – Buckingham Π Theorem and method, application for developing semi – empirical non- dimensional correlation for convection heat transfer – Significance of non-dimensional numbers – Concepts of Continuity, Momentum and Energy Equations – Integral Method as approximate method -Application of Von Karman Integral Momentum Equation for flat plate with different velocity profiles.

Forced convection: External Flows: Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders.

UNIT – IV

Internal Flows: Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal flow based on this –Use of empirical relations for Horizontal Pipe Flow and annulus flow.

Free Convection: Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes.
Heat Exchangers: Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.

UNIT - V
Heat Transfer with Phase Change:
Boiling: – Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling.
Condensation: Film wise and drop wise condensation –Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations.
Radiation Heat Transfer: Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.

TEXT BOOKS:
1. Heat and Mass Transfer – Dixit /Mc Graw Hill
2. Heat and Mass Transfer / Altamush Siddiqui/ Cengage

REFERENCE BOOKS:
1. Essential Heat Transfer - Christopher A Long / Pearson
2. Heat Transfer –Ghoshdastidar / Oxford

AE812PE: CRYOGENICS (PE – V)

B.Tech. IV Year AE II Sem.	L	T/P/D	C
	3	0/0/0	3

Pre-Requisites: Nil

Course Objectives:

- Understand the behavior of fluids at cryogenic temperatures and utilize the feature for cryogenic application in aerospace propulsion.
- Analyze the behavior of solids at cryogenic temperatures and develop systems used in hybrid rocket propulsion systems.
- Estimate thermodynamically gas liquefaction systems and elucidate the application of liquefied gas in aerospace propulsion.
- Create thermodynamically gas separation systems and experiment in a sustained environment for possible synthesis of rarefied gases for testing.

Course Outcomes:

- Cryogenic propulsion system

UNIT- I

Introduction to Cryogenics: Thermo physical and fluid dynamic properties of liquid and gas hydrogen, Thermo physical and fluid dynamic properties of liquid and gas helium, Liquefaction systems of hydrogen and helium gases, Liquefaction systems of hydrogen and helium gases, Refrigeration and liquefaction principals; Joule Thomson effect and inversion curve; Adiabatic and isenthalpic expansion with their comparison.

UNIT- II

Properties of Cryogenic Substance: Cryogenic fluids, Solids at cryogenic temperatures; Superconductivity, Recuperative – Linde – Hampson, Claude, Cascade, Heylandt, Kapitza, Collins, Simon; Regenerative – Stirling cycle and refrigerator, Slovay refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator, Pulse Tube refrigerator; Liquefaction of natural gas.

UNIT- III

Cryogenic Insulations: Vacuum insulation, Evacuated porous insulation, Gas filled Powders and fibrous materials. Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations.

UNIT- IV

Storage and Instrumentation of Cryogenic Liquids: Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system; Cool-down of storage and transfer systems, Measurement of strain, pressure, flow, liquid level and Temperature in cryogenic environment; Cryostats.

UNIT - V

Cryogenic Equipments: Cryogenic heat exchangers – recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders; Turbo alternators; Effect of component inefficiencies; System Optimization, Magneto-caloric refrigerator; 3He-4He Dilution refrigerator; Cryopumping; Cryogenic Engineering applications in energy, aeronautics, space, industry, biology, preservation Application of Cryogenic Engineering in Transport.

TEXT BOOKS:

1. Flynn, T.M., Dekker, Marcel —Cryogenic Engineeringll, Plenum Press, USA, 2009.

2. Timmerhaus, K.D, Flynn, T.M, —Cryogenic Process Engineering‖, Plenum Press, USA, 2009.

REFERENCE BOOKS:

1. Bose A. and Sengupta P.—Cryogenics: Applications and Progress‖, Tata McGraw Hill, 2010.
2. Barron R., —Cryogenic Systems‖, Oxford University Press, 2012.
3. Haselden, G.G., Cryogenic Fundamentals‖, Academic Press, 2012.

AE813PE: AERO ENGINE DESIGN (PE – V)

B.Tech. IV Year AE II Sem.	L	T/P/D	C
	3	0/0/0	3

Pre-Requisites: Aerodynamics, Aircraft Performance, Aircraft Propulsion

Course Objectives:

- Perform parametric and performance analysis of aircraft engines to achieve engine performance requirements identified in constraint and mission analysis.
- Describe the fundamental thermodynamic and gas dynamic principles used in the parametric analysis and performance analysis of aero engines.
- Explain the fundamental design tools used for analysis and preliminary design of main burner and afterburner, fundamental design tools used for analysis and preliminary design of inlet and nozzle.
- Demonstrate, Analyze and choose appropriate materials used in rockets& missiles, mission and weight requirements.

Course Outcomes:

- Engine design requirements and selection criteria

UNIT- I

Fundamentals Of Engine Design: Engine design roadmap, preliminary propulsion design sequence, basic definitions, unit conversions, standard atmosphere, compressible flow equations, mission profile, performance requirements and constraints, desired capabilities.

UNIT- II

Constraint Analysis And Mission Analysis: Concept, design tools, preliminary estimates for constraint analysis, examples of constraint analysis, selection of preliminary design point, complete constraint boundary conditions, constant speed climb, horizontal acceleration, climb and acceleration, takeoff acceleration, constant altitude and speed cruise, constant altitude and speed turn, best subsonic cruise Mach number and altitude, liter, warm-up, takeoff rotation, constant energy height maneuver, general determination of takeoff weight, example and sample mission analysis

UNIT- III

Engine Selection: Parametric cycle analysis, station numbering, gas model, component efficiencies, engine performance analysis, computational inputs and outputs, finding plausible solutions. Parametric and performance behaviors, examples, integrated results, design choices, performance cycle analysis, component performance analysis, iterative solution scheme, component behavior.

UNIT- IV

Engine Sizing: Subsonic inlets, supersonic inlets, nozzles, drag, sizing, constraints, selecting number of engines, final reprise, engine system design, engine static structure, starting, overall operation.

UNIT- V

Engine Component Operation: Operation lines, fan and compressor aerodynamics, turbine aerodynamics, engine life, high pressure and low-pressure turbine design, combustion system components, combustion process, fuels, and ignition, afterburners, sample inlet and exhaust nozzle design.

TEXT BOOK:

1. Mattingly J.D., Heiser W.H., Pratt D.T., —Aircraft Engine Design‖, AIAA ES, 2nd Edition, 2002.

REFERENCE BOOKS:

1. Mathur, M., and Sharma, R.P., — Gas Turbines and Jet and Rocket Propulsion‖, Standard Publishers, New Delhi 1998
2. Cornelisse, J.W., —Rocket Propulsion and Space Dynamics‖, J.W., Freeman & Co. Ltd., London, 1982
3. Parker, E.R., —Materials for Missiles and Spacecraft‖, McGraw-Hill Book Co. Inc., 1982

AE821PE: PRECISION ENGINEERING (PE – VI)

B.Tech. IV Year AE II Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Pre-Requisites: Nil

Course Objectives:

- Understand the BIS code fits and tolerances for geometrical dimensioning and tolerance (GD & T).
- Understand the principal application of different measuring instruments.
- Summarize the application of latest manufacturing techniques (nano).

Course Outcomes:

- Tolerance and accuracy
- Nano measurements techniques

UNIT- I

Accuracy and Alignment Tests: Accuracy and alignment tests: General concept of accuracy, spindle rotation accuracy, test methods, displacement accuracy, dimensional wear of cutting tools, accuracy of NC systems, clamping errors, setting errors, location of rectangular prism, cylinder, basic type of tests, measuring instruments used for testing machine tools, alignment tests, straightness, flatness, parallelism, squareness, circularity, cylindricity.

UNIT- II

Influence of Static Stiffness, Thermal Effects: Influence of static stiffness, thermal effects: Static stiffness, nature of deformation in a machine tool, overall stiffness of a lathe, compliance of work piece, errors due to the variation of the cutting force and total compliance, accuracies due to thermal effects, methods of decreasing thermal effects-Influence of vibration on accuracy.

UNIT- III

Precision Machining: Top down and bottom up approach, development of nanotechnology, precision and micromachining, diamond turning of parts to nanometer accuracy. Stereo microlithography, machining of micro-sized components, mirror grinding of ceramics, ultra-precision block gauges.

UNIT- IV

Nano Measuring Systems: In-process measurement of position of processing point, post process and online measurement of dimensional features, mechanical measuring systems, optical measuring systems, electron beam measuring systems, pattern recognition and inspection systems.

UNIT- V

Lithography: Nano Lithography, photolithography, nano lithography, photolithography, electron beam lithography, ion beam lithography, optical lithography, LIGA process, dip pen lithography, deep UV.

TEXT BOOKS:

1. Murthy R. L, ―Precision Engineering in Manufacturing‖, New Age International, New Delhi, 2005.
2. Norio Taniguchi, ―Nanotechnology‖, Oxford university press, Cambridge, 1996.

REFERENCE BOOKS:

1. Lee Tong Hong, ―Precision Motion control, Design and Implementation‖, Springer Verlag, UK, 2001.
2. Liangchi Zhang, ―Precision Machining of Advanced Materials‖, Trans Tech Publications Ltd., Switzerland, 2001.
3. Hiromu Nakazawa, ―Principles of precision engineering‖, Oxford university press, 1994.

AE822PE: PRACTICAL NON-DESTRUCTIVE TESTING (PE – VI)

B.Tech. IV Year AE II Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Pre-Requisites: Nil

Course Objectives:

- Understanding the basic principles of various non-destructive testing methods, fundamentals, discontinuities in different product forms.
- Differentiate various defect types and select the appropriate non-destructive testing methods for better evaluation of the specimen.
- Implement and document a written procedure paving the way for further training in specific techniques of non-destructive inspection of the experimental subject.
- Recognize the principles and operational techniques of the radiographic testing followed by its interpretation and evaluation.

Course Outcomes:

- Different type of testing
- Principles of electronic measurement devices

UNIT - I

Overview of Non-Destructive Testing: NDT versus mechanical testing, overview of the non-destructive testing methods for the detection of manufacturing defects as well as material characterization; Relative merits and limitations, various physical characteristics of materials and their applications in NDT, visual inspection, v unaided and aided.

UNIT - II

Surface Non-Destructive Examination Methods:

Liquid Penetrant Testing: Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results;

Magnetic particle testing: Theory of magnetism, inspection materials magnetisation methods, interpretation and evaluation of test indications, principles and methods of demagnetization, residual magnetism.

UNIT - III

Thermography and Eddy Current Testing (ET):

Thermography: Principles, contact and non-contact inspection methods, Techniques for applying liquid crystals. Advantages and limitation, infrared radiation and infrared detectors, instrumentations and methods, applications;

Eddy Current Testing: Generation of eddy currents, properties of eddy currents, Eddy current sensing elements, probes, instrumentation, types of arrangement, applications, advantages, limitations, interpretation/evaluation.

UNIT - IV

Ultrasonic Testing (UT) and Acoustic Emission (AE):

Ultrasonic Testing: Principle, transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A-scan, B-scan, C-scan; Phased array ultrasound, time of flight diffraction; Acoustic emission technique, V principle, AE parameters, applications.

UNIT - V

Experimental Methods: Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, inverse square, law, characteristics of films, graininess, density, speed, contrast, characteristic curves, pentameters, exposure charts,

radiographic equivalence. Fluoroscopy; Xerox; Radiography, computed radiography, computed tomography.

TEXT BOOKS:

1. Baldev Raj, T. Jayakumar, M. Thavasimuthu —Practical Non-Destructive Testing, Narosa Publishing House, 2009.
2. Ravi Prakash, —Non-Destructive Testing Techniques, 1st revised edition, New Age International Publishers, 2010.

REFERENCE BOOKS:

1. Paul E Mix, —Introduction to Non-destructive testing: a training guide, Wiley, 2nd Edition New Jersey, 2005.
2. Charles, J. Hellier, —Handbook of Non-destructive evaluation‖, McGraw Hill, New York 2001.

AE823PE: CAD/CIM (PE – VI)

B.Tech. IV Year AE II Sem.	**L**	**T/P/D**	**C**
	3	**0/0/0**	**3**

Pre-Requisites: Nil

Course Objectives:

- Understand the basics of computer aided designing, computer aided manufacturing and computer integrated manufacturing.
- To study about group technology, computer aided process planning, material requirement planning (MRP) Enterprise resource planning (ERP).
- Gain knowledge about shop floor control and Flexible manufacturing systems (F.M.S).
- Emphasizes the integration of manufacturing enterprise using computer integrated manufacturing (CIM) technologies.

Course Outcomes:

- Industry need and manufacturing process

UNIT- I

Introduction: Computers in industrial manufacturing, product cycle, CAD/CAM hardware, basic structure, CPU, memory types, input devices, display devices, hard copy devices, and storage devices, computer graphics, raster scan graphics coordinate system, database structure for graphics modelling, transformation of geometry, three dimensional transformations, mathematics of projections, clipping, hidden surface removal.

UNIT- II

Geometric Modelling: Requirements, geometric models, geometric construction models, curve representation methods, surface representation methods, modelling facilities desired, drafting and modelling systems, basic geometric commands, layers, display control commands, editing, dimensioning and solid modelling.

UNIT- III

Group Technology Computer Aided Process Planning: History of group technology, role of G.T in CAD/CAM integration, part families, classification and coding, DCLASS and MCLASS and OPTIZ coding systems, facility design using G.T, benefits of G.T, cellular manufacturing. Process planning, role of process planning in CAD/CAM integration, approaches to computer aided process planning, variant approach and generative approaches, CAPP and CMPP systems.

UNIT- IV

Computer Aided Planning and Control, Shop Floor Control And Introduction To FMS: Production planning and control, cost planning and control, inventory management, material requirements planning (ERP), control, phases, factory data collection system, automatic identification methods, bar code technology, automated data collection system; FMS, components of FMS, types, FMS workstation, material handling and storage system, FMS layout, computer control systems, applications and benefits.

UNIT-V

COMPUTER AIDED PLANNING AND CONTROL AND COMPUTER MONITORING

Production planning and control, cost planning and control, inventory management, material requirements planning (MRP), shop floor control, lean and agile manufacturing, types of production monitoring systems, structure model of manufacturing, process control and strategies, direct digital control.

TEXT BOOKS:

1. Zimmers, P. Groover, —CAD/ CAM‖, Prentice- Hall India, 2008.
2. Zeid, Ibrahim, —CAD / CAM Theory and Practice‖, Tata McGraw-Hill, 1997.
3. Mikell. P. Groover —Automation, Production Systems and Computer Integrated Manufacturing‖, Pearson Education 2001.
4. Ranky, Paul G., —Computer Integrated Manufacturing‖, Prentice hall of India Pvt. Ltd., 2005
5. Yorem Koren, —Computer Integrated Manufacturing‖, McGraw Hill, 2005.

REFERENCE BOOKS:

1. P. Groover, Automation, —Production Systems & Computer Integrated Manufacturing‖, Pearson Education. 2nd Edition 1989.
2. Lalit Narayan, —Computer Aided Design and Manufacturing‖, Prentice-Hall India. 3rd Edition 2002.
3. Radhakrishnan, Subramanian, —CAD / CAM / CIM‖, New Age.4th Edition 2016.
4. Jami J Shah, Martti Mantyla, —Parametric and Feature-Based CAD/CAM: Concepts, Techniques, and Applications‖, John Wiley & Sons Inc, 1995.
5. Alavala, —CAD/ CAM: Concepts and Applications‖, PHI Publications, 4th Edition, 2016.
6. W. S. Seames, —Computer Numerical Control Concepts and Programming‖, 4th Edition 1999.