JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B.Tech. in AERONAUTICAL ENGINEERING

III YEAR COURSE STRUCTURE AND SYLLABUS (R18)
Applicable From 2018-19 Admitted Batch

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**

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

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.

Professional Elective – I

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

AE501PC: AIRCRAFT PROPULSION

B.Tech. III Year AE I Sem.	L	T/P/D	C
	3	1/0/0	4

Pre-Requisites: Nil

Course Objectives:

- Analyse parametric cyclic analysis, performance parameters, efficiency, specific impulse of all air breathing engines.
- Know the design and performance of subsonic and supersonic inlets, types of combustion chambers and factors affecting the combustors.
- Discuss the types of nozzles, flow conditions in nozzles, interaction of nozzle flow with adjacent surfaces and thrust reversal
- Explain different types of compressors and turbines, work done, velocity diagrams and stage efficiency calculations.

Course Outcomes:

- Review the basic thermodynamic principles and fundamentals of gas turbine engines
- Outline the concepts of subsonic and supersonic inlets for jet engines
- Evaluate the operating characteristics of compressors and turbines in terms of blade shapes, angles, and direction of rotation
- Describe the fundamentals of combustion chamber, nozzle, ramjet and rocket propulsion

UNIT - I

Air-Breathing Engines Classes: Classification, operational envelopes; Description and function of gas generator, turbojet, turbofan, turboprop, turbo shaft, ramjet, scramjet, turbojet/ramjet combined cycle engine; Engine thrust, takeoff thrust, installed thrust, thrust equation; Engine performance parameters, specific thrust, specific fuel consumption and specific impulse, thermal efficiency, propulsive efficiency, engine overall efficiency and its impact on aircraft range and endurance; Engine cycle analysis and performance analysis for turbojet, turbojet with afterburner, turbofan engine, turboprop engine.

UNIT - II

Inlets And Combustion Chambers: Internal flow and stall in subsonic inlets, relation between minimum area ratio and eternal deceleration ratio, diffuser performance, supersonic inlets, starting problem on supersonic inlets, shock swallowing by area variation; Classification of combustion chambers, combustion chamber performance, effect of operating variables on performance, flame stabilization.

UNIT - III

Nozzles: Theory of flow in isentropic nozzles, nozzles and choking, nozzle throat conditions, nozzle efficiency, losses in nozzles. Over expanded and under expanded nozzles, ejector and variable area nozzles, interaction of nozzle flow with adjacent surfaces, thrust reversal.

UNIT - IV

Compressors: Principle of operation of centrifugal compressor and axial flow compressor, work done and pressure rise, velocity triangles, degree of reaction, free vortex and constant reaction designs of axial flow compressor, performance characteristics of centrifugal and axial flow compressors, stage efficiency calculations, cascade testing.

UNIT - V

Turbines: Principle of operation of axial flow turbines, limitations of radial flow turbines, work done and pressure rise, velocity triangles, degree of reaction, free vortex and constant angle designs,

performance characteristics, sample ramjet design calculations, flame stability problems in ramjet combustors, integral ram rockets.

TEXT BOOKS:

1. Hill, P.G. & Peterson, C.R. —Mechanics & Thermodynamics of Propulsion‖ Addison Wesley Longman INC, 1999.
2. Mattingly J.D., —Elements of Propulsion: Gas Turbines and Rocket‖, AIAA, 1991.

REFERENCE BOOKS:

1. Cohen, H. Rogers, G. F.C. and Saravanamuttoo, H.I.H. —Gas Turbine Theory‖, Longman, 1989.
2. Oates, G.C. - Aero thermodynamics of Aircraft Engine Components‖, AIAA Education Series, New York, 1985.

AE502PC: HIGH SPEED AERODYNAMICS

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

Pre-Requisites: Low speed aerodynamics

Course Objectives:

- Understand the effect of compressibility at high-speeds and the ability to make intelligent design decisions.
- Explain the dynamics in subsonic, transonic and supersonic flow regimes in both internal and external geometries.
- Analyze the airfoils at subsonic, transonic and supersonic flight conditions using the perturbed flow theory assumption.
- Formulate appropriate aerodynamic models to predict the forces and performance of realistic three-dimensional configurations.

Course Outcomes:

- Air compressibility and isentropic relations inform of speed
- Shock and expansion waves,
- Supersonic wind tunnel, nozzle design, flow visualisation technique

UNIT-I

INTRODUCTION TO COMPRESSIBLE FLOWS: Basic concepts: Introduction to compressible flow, brief review of thermodynamics and fluid mechanics, integral forms of conservation equations, differential conservation equations, continuum postulates, acoustic speed and mach number, governing equations for compressible flows.

UNIT-II

SHOCK AND EXPANSION WAVES: Shocks and expansion waves: Development of governing equations for normal shock, stationery and moving normal shock waves, applications to aircrafts, supersonic wind tunnel, shock tubes, shock polars, supersonic pitot probes; oblique shocks, governing equations, reflection of shock, Prandtl-Meyer expansion flow, shock expansion method for flow over airfoil, introduction to shock wave boundary layer interaction.

UNIT-III

ONE DIMENSIONAL AND QUASI ONE-DIMENSIONAL FLOW: Quasi one-dimensional flow: Isentropic flow in nozzles, area Mach relations, choked flow, under and over expanded nozzles, slip stream line. One dimensional flow: Flow in constant area duct with friction and heat transfer, Fanno flow and Rayleigh flow, flow tables and charts for Fanno flow and Rayleigh flow.

UNIT-IV

APPLICATIONS OF COMPRESSIBLE FLOWS AND NUMERICAL TECHNIQUES: Small perturbation equations for subsonic, transonic, supersonic and hypersonic flow; Experimental characteristics of airfoils in compressible flow, supercritical airfoils, area rule; Theory of characteristics, determination of the characteristic lines and compatibility equations, supersonic nozzle design using method of characteristics.

UNIT-V

EXPERIMENTAL METHODS IN COMPRESSIBLE FLOWS: Experimental methods: Subsonic wind tunnels, supersonic wind tunnels, shock tunnels, free-piston shock tunnel, detonation-driven shock tunnels, and expansion tubes and characteristic features, their operation and performance, flow visualization techniques for compressible flows.

TEXT BOOKS:

1. John D. Anderson, —Modern Compressible flow with historical perspective‖, McGraw-Hill Education, 3rd Edition, 2002.
2. John D. Anderson, —Fundamentals of Aerodynamics‖, McGraw-Hill Education, 6th Edition, 2016.

REFERENCE BOOKS:

1. Ascher H. Shapiro, —The Dynamics and Thermodynamics of Compressible Fluid Flow‖ John Wiley & Sons; Volume 1 ed. Edition, 1977.
2. Radhakrishnan Ethirajan, —Gas Dynamics‖, John Wiley & Sons, 2nd edition 2010.
3. H W Liepmann and A Roshko, —Elements of Gas Dynamics‖, John Wiley & Sons, 4th edition, 2003.

AE503PC: FINITE ELEMENT METHODS

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

Pre-requisites: Mechanics of Solids

Course Objective: The aim of the course is to provide the participants an overview on Finite Element Method, Material models, and Applications in Civil Engineering. At the end of the course, the participants are expected to have fair understanding of:

- Basics of Finite Element Analysis.
- Available material models for structural materials, soils and interfaces/joints.
- Modeling of engineering systems and Soil–Structure Interaction (SSI).
- Importance of interfaces and joints on the behavior of engineering systems.
- Implementation of material model in finite element method and applications

Course Outcomes: At the end of the course, the student will be able to, Apply finite element method to solve problems in solid mechanics, fluid mechanics and heat transfer. Formulate and solve problems in one dimensional structures including trusses, beams and frames. Formulate FE characteristic equations for two dimensional elements and analyze plain stress, plain strain, axi-symmetric and plate bending problems. ANSYS, ABAQUS, NASTRAN, etc.

UNIT – I

Introduction to Finite Element Methods: General Procedure – Engineering Applications – Stress and Equilibrium, Strain – Displacement relations. Stress – strain relations: Finite Elements: 1- Dimensional, 2 – Dimensional, 3-Dimensional & Interpolation Elements

One Dimensional Problems: 1-D Linear and 1-D Quadratic Elements - Finite element modeling, Coordinates and shape functions. Assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.

UNIT – II

Analysis of Trusses: Derivation of Stiffness Matrix for Plane Truss, Displacement of Stress Calculations.

Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node beam element, Load Vector, Deflection.

UNIT – III

Finite element modeling of two-dimensional stress analysis with constant strain triangles and treatment of boundary conditions, Estimation of Load Vector, Stresses

Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements. Two dimensional four noded Isoparametric elements and numerical integration.

UNIT – IV

Steady State Heat Transfer Analysis: one dimensional analysis of Slab, fin and two-dimensional analysis of thin plate.

UNIT – V

Dynamic Analysis: Formulation of finite element model, element - Mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar, truss and beam.

Finite element – formulation to 3 D problems in stress analysis, convergence requirements, Mesh generation. techniques such as semi-automatic and fully Automatic use of softwares such as ANSYS, ABAQUS, NASTRAN using Hexahedral and Tetrahedral Elements.

TEXT BOOKS:

1. Finite Element Methods: Basic Concepts and applications/Alavala/PHI
2. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu /Pearson

REFERENCE BOOKS:

1. An Introduction to the Finite Element Method / J. N. Reddy/ Mc Graw Hill
2. Finite Element Analysis / SS Bhavikatti / New Age
3. Finite Element Method/ Dixit/Cengage

SM504MS: BUSINESS ECONOMICS AND FINANCIAL ANALYSIS

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

Course Objective: To learn the basic business types, impact of the economy on Business and Firms specifically. To analyze the Business from the Financial Perspective.

Course Outcome: The students will understand the various Forms of Business and the impact of economic variables on the Business. The Demand, Supply, Production, Cost, Market Structure, Pricing aspects are learnt. The Students can study the firm's financial position by analysing the Financial Statements of a Company.

UNIT – I: Introduction to Business and Economics

Business: Structure of Business Firm, Theory of Firm, Types of Business Entities, Limited Liability Companies, Sources of Capital for a Company, Non-Conventional Sources of Finance.

Economics: Significance of Economics, Micro and Macro Economic Concepts, Concepts and Importance of National Income, Inflation, Money Supply and Inflation, Business Cycle, Features and Phases of Business Cycle. Nature and Scope of Business Economics, Role of Business Economist, Multidisciplinary nature of Business Economics.

UNIT - II: Demand and Supply Analysis

Elasticity of Demand: Elasticity, Types of Elasticity, Law of Demand, Measurement and Significance of Elasticity of Demand, Factors affecting Elasticity of Demand, Elasticity of Demand in decision making, Demand Forecasting: Characteristics of Good Demand Forecasting, Steps in Demand Forecasting, Methods of Demand Forecasting.

Supply Analysis: Determinants of Supply, Supply Function and Law of Supply.

UNIT- III: Production, Cost, Market Structures & Pricing

Production Analysis: Factors of Production, Production Function, Production Function with one variable input, two variable inputs, Returns to Scale, Different Types of Production Functions.

Cost analysis: Types of Costs, Short run and Long run Cost Functions.

Market Structures: Nature of Competition, Features of Perfect competition, Monopoly, Oligopoly, Monopolistic Competition.

Pricing: Types of Pricing, Product Life Cycle based Pricing, Break Even Analysis, Cost Volume Profit Analysis.

UNIT - IV: Financial Accounting: Accounting concepts and Conventions, Accounting Equation, Double-Entry system of Accounting, Rules for maintaining Books of Accounts, Journal, Posting to Ledger, Preparation of Trial Balance, Elements of Financial Statements, Preparation of Final Accounts.

UNIT - V: Financial Analysis through Ratios: Concept of Ratio Analysis, Importance, Liquidity Ratios, Turnover Ratios, Profitability Ratios, Proprietary Ratios, Solvency, Leverage Ratios – Analysis and Interpretation (simple problems).

TEXT BOOKS:

1. D. D. Chaturvedi, S. L. Gupta, Business Economics - Theory and Applications, International Book House Pvt. Ltd. 2013.
2. Dhanesh K Khatri, Financial Accounting, Tata Mc –Graw Hill, 2011.
3. Geethika Ghosh, Piyali Gosh, Purba Roy Choudhury, Managerial Economics, 2e, Tata Mc Graw Hill Education Pvt. Ltd. 2012.

REFERENCES:

1. Paresh Shah, Financial Accounting for Management 2e, Oxford Press, 2015.
2. S. N. Maheshwari, Sunil K Maheshwari, Sharad K Maheshwari, Financial Accounting, 5e, Vikas Publications, 2013.

AE505PC: AIRCRAFT SYSTEMS AND CONTROLS

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

Pre-Requisites: Nil

Course Objectives:

- Explain the concept and meaning of system and classify the various systems required for aircraft and their contribution in order to fulfil the aircraft tasks.
- Describe the various types of Electrical power generations and distribution in aircraft.
- Impart the knowledge of pneumatic, hydraulic and environmental control system.
- Demonstrate different actuators, flight control system and advanced flight actuation system.

Course Outcomes:

- The principles of flight control
- The principle and working of electronic and mechanical control systems
- Various types of aircraft instruments
- Static & dynamic characteristics of instruments

UNIT- I

Introduction To Aircraft Systems: System concepts, everyday examples of systems, sub-systems; Generic system definition, inputs, outputs, feedback, external influence. Aircraft systems- airframe systems, vehicle systems, avionics systems, mission systems and their sub-systems; Specification of requirements, mission requirements, performance requirements; Operating environment conditions.

UNIT- II

Electrical Systems and Air Conditioning, Pressurizing Systems: Electrical loads in aircraft. Electrical power generation and control- DC, AC- types. Power distribution- primary, secondary. Power conversion and energy storage; Load protection; Electrical load management systems, variable speed constant frequency (VSCS) cycloconverter, 270 V DC systems; Basic air cycle systems; Vapour cycle systems, boost-strap air cycle system; Evaporative vapour cycle systems; Evaporative air cycle systems; Oxygen systems; Fire protection systems, de-icing and anti icing systems.

UNIT- III

Hydraulic Systems and Pneumatic Systems: Hydraulic systems: Study of typical workable system, function, merits, application, system loads, design requirements; Principal components; Hydraulic fluid: required properties, operating fluid pressures, temperatures, and flow rates; Hydraulic piping, pumps, reservoir, accumulator; Landing gear and brake management systems. Pneumatic systems; Advantages; - Working principles; Typical air pressure system; Brake system; Typical pneumatic power system; Components, landing gear systems; Classification.

UNIT- IV

Engine Control and Fuel Systems: Principle of operation of aircraft gas turbine engines; Engine - airframe interfaces; Control of fuel flow, air flow, exhaust gas flow- need, means, system parameters, basic inputs and outputs; Limited authority control systems, full authority control systems- examples; Engine monitoring- sensors, indicators; Power off takes- need, types, effect on engine performance; Fuel systems- characteristics, components, operating modes; Fuel tank safety- fuel inserting system.

UNIT- V

Airplane Control Systems: Flight control systems- primary and secondary flight control conventional systems; Power assisted and fully powered flight controls ; Power actuated systems; Engine control systems; Push pull rod system, flexible push full rod system; Components; Modern control systems;

Digital fly by wire systems , control laws, implementation; Auto pilot system active control technology, communication and navigation systems instrument landing systems; Control linkages, actuation- types, description and redundancy.

TEXT BOOKS:

1. Moir, I. and Sea bridge, A, —Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration‖, John Wiley, 3rd Edition 2008.
2. Moir, I. and Sea bridge, A, —Design and Development of Aircraft Systems- An Introduction‖, AIAA Education Series‖, AIAA, 2004.

REFERENCE BOOKS:

1. Pallett, E.H.J., —Aircraft Instruments and Integrated Systems‖, Longman Scientific &Technical 10th edition, 1992.
2. Harris, D, —Flight Instruments and Automatic Flight Control Systems‖, 6th edition, 2004.
3. Bolton, W., —Pneumatic and Hydraulic Systems‖, Butterworth-Heinemann.

AE506PC: AIRCRAFT PERFORMANCE AND STABILITY

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

Pre-Requisite: Low speed aerodynamics

Course Objectives:

- Learn the different Regimes of aircraft and performance requirements at different atmospheric conditions.
- Understand the different type of velocities and gives differences between stall velocity and maximum and minimum velocities.
- Estimate the time to climb and descent and gives the relation between rate of climb and descent and time to climb and descent at different altitudes.
- Illustrate the velocity and radius required for different type of maneuvers like pull-up, pull down and steady turn.

Course Outcomes:

- Aerodynamic characteristics, engine performance, and effects of flight altitude on aircraft performance
- Predict and analyse the performance of an airplane for accelerating and Non-accelerating cases
- Calculate the range and endurance of propeller and jet driven airplane
- Describe the different aircraft maneuvers

UNIT-I

Introduction to Aircraft Performance: The role and design mission of an aircraft; Performance requirements and mission profile; Aircraft design performance, the standard atmosphere; Off-standard and design atmosphere; Measurement of air data; Air data computers; Equations of motion for performance - the aircraft force system; Total airplane drag- estimation, drag reduction methods; The propulsive forces, the thrust production engines, power producing engines, variation of thrust, propulsive power and specific fuel consumption with altitude and flight speed; The minimum drag speed, minimum power speed; Aerodynamic relationships for a parabolic drag polar.

UNIT- II

Cruise Performance: Maximum and minimum speeds in level flight; Range and endurance with thrust production, and power producing engines; Cruise techniques: constant angle of attack, constant mach number; constant altitude, methods- comparison of performance. The effect of weight, altitude and temperature on cruise performance; Cruise performance with mixed power-Plants.

UNIT- III

Climb and Decent Performance: Importance of Climb and descent performance, Climb and descent technique generalized performance analysis for thrust producing, power producing and mixed power plants, maximum climb gradient, and climb rate. Energy height and specific excess power, energy methods for optimal climbs - minimum time, minimum fuel climbs. Measurement of best climb performance. Descent performance in Aircraft operations. Effect of wind on climb and decent performance.

UNIT- IV

Aircraft Manoeuvre Performance: Lateral maneuvers- turn performance- turn rates, turn radius-limiting factors for turning performance. Instantaneous turn and sustained turns, specific excess power, energy turns. Longitudinal aircraft maneuvers, the pull-up, maneuvers. The maneuver envelope, Significance. Maneuver boundaries, Maneuver performance of military Aircraft, transport Aircraft.

UNIT- V

Safety Requirements -Take-off And Landing Performance and Flight Planning: Estimation of takeoff distances. The effect on the takeoff distance of weight wind, runway conditions, ground effect. Takeoff performance safety factors. Estimation of landing distances. The discontinued landing, Baulk landing, air safety procedures and requirements on performance. Fuel planning fuel requirement, trip fuel, Environment effects, reserve, and tankering**.**

TEXT BOOKS:

1. Anderson, J.D. Jr., ―Aircraft Performance and Design‖, International edition McGraw Hill, 1st Edition, 1999, ISBN: 0-07-001971-1.
2. Eshelby, M.E., ―Aircraft Performance theory and Practice‖, AIAA Education Series, AIAA, 2nd Edition, 2000, ISBN: 1-56347-398-4.

REFERENCE BOOKS:

1. McCormick, B.W, ―Aerodynamics, Aeronautics and Flight Mechanics‖, John Wiley, 2nd Edition, 1995, ISBN: 0-471-57506-2.
2. Yechout, T.R. et al., ―Introduction to Aircraft Flight Mechanics‖, AIAA Education Series, AIAA, 1st Edition, 2003, ISBN: 1-56347-577-4.
3. Shevel, R.S., ―Fundamentals of Flight‖, Pearson Education, 2nd Edition, 1989, ISBN: 81-297-0514-1.

AE507PC: COMPUTER AIDED AIRCRAFT ENGINEERING DRAWING

B.Tech. III Year AE I Sem.	**L**	**T/P/D**	**C**
	0	**0/2/0**	**1**

Pre-Requisites: Engineering Graphics

Course Objectives:

- Understand the concepts and various tools used in design module
- Understand the design of typical structural components.
- Understand the design of typical aircraft components.
- Understand the design of three view diagram of a typical aircraft.

Course Outcomes:

- Exposure to computer aided design and drafting software
- Learn part design and assembly by design tool

LIST OF EXPERIMENTS

Week-I: SKETCHER; Interface, Sketch Tools, View Tool bar, Profile Tool bar, Operation Tool bar, Tools, Constrain tool bar, Transformation Tool bar, User Selection Filter, Standards, Visualizations.
Week-2: PART DESIGN; Sketch Based Features, Dress up Features, Transformation Features, Reference Elements, Measure, Thickness, Boolean Operations.
Week-3: SHEET METAL DESIGN; Walls, Cutting and Stamping, Bending, Rolled Walls,
Week-4: SURFACE DESIGN; Surfacer, Operations, Wireframe, Replication.
Week-5: ASSEMBLY; Product Structure Tools, Constrains.
Week-6: GD&T ; Introduction to Geometric Dimensioning and Tolerance, Weld Symbols, GD&T Symbols, Types of Tolerances, Types of views, Roughness Symbols.
Week-7: DRAFTING; Views, Annotations, Sheet Background.
Week-8: DESIGN OF AIRCRAFT WING; Design of any two types of Aircraft structures
Week-9: DESIGN OF FUSELAGE; Design of fuselage with internal components
Week-10: DESIGN OF NOSE CONE; Design of Nose cone structures
Week-11: DESIGN OF LANDING GEAR; Design of Main landing gear and nose landing gear

Reference Books:

1. http://www.ehu.eus/asignaturasKO/DibujoInd/Manuales/R12_manual_catia_v5.pdf
2. http://www.engr.psu.edu/xinli/edsgn497k/TeaPotAssignment.pdf
3. http://file1.engineering.com/pdf/PartDesign.pdf

AE508PC: FLIGHT CONTROL LAB

B.Tech. III Year AE I Sem.	L	T/P/D	C
	0	0/2/0	1

Pre-Requisites: Aircraft Performance & Stability

Course Objectives:

- Understand the basics simulation of unaccelerated and accelerated level flight for climb and descend
- Analyse the take-off and landing performance and ground roll for different modes of aircraft.
- Identify the basic controls and manoeuvre of in complex flight Path

Course Outcomes:

- Exposure to flight simulation
- Exposure to MATLAB

LIST OF EXPERIMENTS

Week-1: SIMULATION OF UNACCELERATED AND ACCELERATED LEVEL FLIGHT

1. Simulation of steady flight

Week-2: SIMULATION OF UNACCELERATED AND ACCELERATED CLIMB

1. Simulation of steady climb

Week-3: SIMULATION OF UNACCELERATED AND ACCELERATED DESCENT

1. Simulation of steady descent

Week-4: SIMULATION OF TAKE-OFF PERFORMANCE

1 Estimation of takeoff velocity

Week-5: SIMULATION OF LANDING PERFORMANCE

1. Estimation of ground roll distance
2. Estimation of total landing distance

Week-6: SIMULATION OF CONVENTIONAL FLIGHT PATH

1. Perform the given mission profiles

Week-7: STABILIZATION OF LONGITUDINAL PERTURBED AIRCRAFT

1. Perform the operation from disturbed flight to trim flight

Week-8: STABILIZATION OF LATERAL PERTURBED AIRCRAFT

1. Simulate lateral directional modes.

Week-9: SIMULATION OF SPIN RECOVERY

1. Perform the operation of spin recovery

Week-10: SIMULATION OF COORDINATED LEVEL TURN

1. Perform the level turn at given turn rate.
2. Perform the level turn at given turn radius.

Week-11: SIMULATION OF BARREL ROLL MANOEUVRE

1. Perform the barrel roll manoeuvre

REFERENCE BOOKS:

Peter John Davison. "A summary of studies conducted on the effect of motion in flight simulator pilot training".
Beard, Steven; et al. "Space Shuttle Landing and Rollout Training at the Vertical Motion Simulator" (PDF). AIAA. Retrieved 5 February 2014.

WEB REFERENCE:

1. https://ch.mathworks.com/help/aeroblks/flight-simulator-interfaces.html

AE509PC: AIRCRAFT PROPULSION LAB

B.Tech. III Year AE I Sem.	L	T/P/D	C
	0	0/2/0	1

Pre-Requisites: Aircraft Propulsion, Thermodynamics

Course Objectives:

- To familiarise the students to the working of jet engines and its different working conditions

Course Outcomes

- To understand how to do the heat transfer analysis over the surface of the aircraft structure, the working of different jet engines

LIST OF EXPERIMENTS

Week-1: Study of jet engines
Week-2: Study of free convective heat transfer over a flat plate
Week-3: Study of forced convective heat transfer over a flat plate
Week-4: Ignition studies of solid and liquid propellants
Week-5: Operation of a ramjet engine
Week-6: Study of free jet
Week-7: Study of wall jet
Week-8: Study of hybrid propulsion system
Week-9: Preparation of fuel grain for hybrid rocket
Week-10: Burning rate measurement of solid propellants in a strand burner

*MC510: INTELLECTUAL PROPERTY RIGHTS

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

UNIT – I

Introduction to Intellectual property: Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

UNIT – II

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

UNIT – III

Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

UNIT – IV

Trade Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation.

Unfair competition: Misappropriation right of publicity, false advertising.

UNIT – V

New development of intellectual property: new developments in trade mark law; copy right law, patent law, intellectual property audits.

International overview on intellectual property, international – trade mark law, copy right law, international patent law, and international development in trade secrets law.

TEXT BOOKS & REFERENCES:

1. Intellectual property right, Deborah. E. Bouchoux, Cengage learning.
2. Intellectual property right – Unleashing the knowledge economy, prabuddha ganguli, Tata McGraw Hill Publishing company ltd.

AE601PC: SPACE PROPULSION

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

Pre-Requisites: Nil

Course Objectives:

- Evaluate various space missions, parameters to be considered for designing trajectories and rocket mission profiles
- Understand the fundamentals of chemical rocket propulsion, types of igniters and performance considerations of rockets.
- Discuss the working principle of solid and liquid propellant rockets and gain basic knowledge of hybrid rocket propulsion.
- Illustrate electric propulsion techniques, ion and nuclear rocket and the performances of different advanced propulsion systems.

Course Outcomes:

- Propulsion system in rockets and missiles
- Type of trajectory and orbits

UNIT - I

Principles of Rocket Propulsion: History of rockets, Newtons third law, orbits and space flight, types of orbits, basic orbital equations, elliptical transfer orbits, launch trajectories, the velocity increment needed for launch, the thermal rocket engine, concepts of vertical takeoff and landing, SSTO and TSTO, launch assists.

UNIT - II

Fundamentals of Rocket Propulsion: Operating principle, Rocket equation, Specific impulse of a rocket, internal ballistics, Rocket nozzle classification, Rocket performance considerations of rockets, types of igniters, preliminary concepts in nozzle less propulsion, air augmented rockets, pulse rocket motors, static testing of rockets and instrumentation, safety considerations.

UNIT - III

Solid Rocket Propulsion: Salient features of solid propellant rockets, selection criteria of solid propellants, estimation of solid propellant adiabatic flame temperature, propellant grain design considerations. Erosive burning in solid propellant rockets, combustion instability, strand burner and T-burner, applications and advantages of solid propellant rockets.

UNIT - IV

Liquid and Hybrid Rocket Propulsion: Salient features of liquid propellant rockets, selection of liquid propellants, various feed systems and injectors for liquid propellant rockets, thrust control cooling in liquid propellant rockets and the associated heat transfer problems, combustion instability in liquid propellant rockets, peculiar problems associated with operation of cryogenic engines, introduction to hybrid rocket propulsion, standard and reverse hybrid systems, combustion mechanism in hybrid propellant rockets, applications and limitations.

UNIT-V

Advanced Propulsion Techniques: Electric rocket propulsion, types of electric propulsion techniques, Ion propulsion, Nuclear rocket, comparison of performance of these propulsion systems with chemical rocket propulsion systems, future applications of electric propulsion systems, Solar sail.

TEXT BOOKS:

1. Hill, P.G. and Peterson, C.R., —Mechanics and Thermodynamics of Propulsion‖, 2nd Edition, Addison Wesley, 1992.
2. Turner, M. J. L., —Rocket and Spacecraft Propulsion‖, 2nd Edition, MIT Press, 1922.
3. Hieter and Pratt, —Hypersonic Air breathing propulsion‖ 5th Edition, 1993.

REFERENCE BOOKS:

1. Sutton, G.P., —Rocket Propulsion Elements‖ John Wiley & Sons Inc., New York, 5th Edition, 1993.
2. Mathur, M. L., and Sharma, R.P., —Gas Turbine, Jet and Rocket Propulsion‖, Standard Publishers and Distributors, Delhi, 1988.
3. Tajmar, M., Advanced Space Propulsion Systems, Springer 2003

AE602PC: COMPUTATIONAL AERODYNAMICS

B.Tech. III Year AE II Sem.	L	T/P/D	C
	3	1/0/0	4

Pre-Requisites: Nil

Course Objectives:

- Discuss the fundamental aspects of numerical discretization and the major theories, approaches and methodologies used in computational aerodynamics.
- Analyze to build up the skills in the actual implementation of computational aerodynamics methods boundary conditions, turbulence modelling etc by using commercial CFD codes.
- Demonstrate the applications of CFD for classic fluid dynamics problems and basic thoughts and philosophy associated with CFD.
- Understand the various grids used in practice, including some recommendations related to grid quality and choose appropriate data structure to solve problems in real world.

Course Outcomes:

- Mesh creation technique
- Solving PDF by using numerical technique

UNIT- I

Introduction to Computational Aerodynamics: Need of computational fluid dynamics, philosophy of CFD, CFD as a research tool as a design tool, applications in various branches of engineering, models of fluid flow finite control volume, infinitesimal fluid element, substantial derivative physical meaning of divergence of velocity, derivation of continuity, momentum and energy equations, physical boundary conditions significance of conservation and non-conservation forms and their implication on CFD applications strong and weak conservation forms shock capturing and shock fitting approaches.

UNIT - II

Mathematical Behavior of Partial Differential Equations and Their Impact On Computational Aerodynamics: Classification of quasi-linear partial differential equations by Cramer‘s rule and Eigen value method, general behavior of different classes of partial differential equations and their importance in understanding physical and CFD aspects of aerodynamic problems at different Mach numbers involving hyperbolic, parabolic and elliptic equations: domain of dependence and range of influence for hyperbolic equations, well-posed problems.

UNIT - III

Basic Aspects of Discretization: Introduction to finite difference: finite difference approximation for first order, second order and mixed derivatives, explicit and implicit approaches, truncation and round-off errors, consistency, stability, accuracy, convergence, efficiency of numerical solutions. Von Neumann stability analysis, physical significance of CFL stability condition. Need for grid generation, structured grids artesian grids, stretched (compressed) grids, body fitted structured grids, H-mesh, C-mesh, O-mesh, I-mesh, multi-block grids, C-H mesh, H-O-H mesh, overset grids, adaptive grids, unstructured grids: triangular, tetrahedral cells, hybrid grids, quadrilateral, hexahedral cells.

UNIT - IV

CFD Techniques: Lax-Wendroff technique, MacCormack‘s technique, Crank Nicholson technique, Relaxation technique, aspects of numerical dissipation and dispersion. Alternating-Direction-Implicit (ADI) Technique, pressure correction technique: application to incompressible viscous flow, need for staggered grid. Philosophy of pressure correction method, pressure correction formula. Numerical procedures: SIMPLE, SIMPLER, SIMPLEC and PISO algorithms, boundary conditions for the pressure correction method.

UNIT-V

Finite Volume Methods: Basis of finite volume method, conditions on the finite volume selections, cell-centered and cell vertex approaches. Definition of finite volume discretization, general formulation of a numerical scheme, two-dimensional finite volume method with example.

TEXT BOOKS:

1. J. D. Anderson, Jr., —Computational Fluid Dynamics- The Basics with Applications‖, McGraw-Hill Inc, 2012.
2. D. A. Anderson, J. C. Tannehill, R. H. Pletcher, —Computational Fluid Mechanics and Heat Transfer‖, 1st edition, 1997.

REFERENCE BOOKS:

1. Hirsch, C., —Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics‖, Vol. I, Butter worth-Heinemann, 2nd edition, 2007.
2. Hoffmann, K. A. and Chiang, S. T., —Computational Fluid Dynamics for Engineers‖, Engineering Education Systems, 4th edition, 2000.
3. Patankar, S.V., —Numerical Heat Transfer and Fluid Flow‖, Hemisphere Pub. Corporation, 1st edition, 1980.

AE603PC: HELICOPTER AERODYNAMICS

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

Pre-Requisites: Low speed aerodynamics

Course Objectives:

- Understand the elements of helicopter aerodynamics and ground effect machines, their components and methods of control.
- Formulate the mathematical model using simple blade element theory, analyze its figure of merit and evaluate power estimations.
- Evaluate performance and its effect on altitude and understand the preliminary stability aspects of helicopters.
- Apply the aerodynamics, propulsion and control concepts for various VTOL and STOL aircraft and ground effect machines.

Course Outcomes:

- Working principle of helicopter
- Types of helicopter

UNIT-I ELEMENTS OF HELICOPTER AERODYNAMICS

Configurations based on torque reaction, jet rotors and compound helicopters, methods of control, collective and cyclic pitch changes, lead and lag, flapping hinges.

UNIT-II IDEAL ROTOR THEORY

Hovering performance, momentum and simple blade element theories, figure of merit, profile and induced power estimation, constant chord and ideal twist rotors.

UNIT-III POWER ESTIMATES

Induced, profile and parasite power requirements in forward flight. Performance curves with effects of altitude, preliminary ideas on helicopter stability.

UNIT-IV LIFT, PROPULSION AND CONTROL OF VSTOL AIRCRAFT

Various configurations: propeller, rotor, ducted fan and jet lift, tilt wing and vectored thrust, performance of VTOL and STOL aircraft in hover, transition and forward motion.

UNIT-V GROUND EFFECT MACHINES

Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machine, drag of hovercraft on land and water, applications of hovercraft.

TEXT BOOKS:

1. Gessow A, and Myers G C, —Aerodynamics of Helicopter‖, Macmillan &Co., 1st Edition 1987.
2. McCormick B W, —Aerodynamics of V/STOL Flight‖, Academic Press, 1st Edition, 1987.

REFERENCE BOOKS:

1. Johnson W, —Helicopter Theory‖, Princeton University Press, 1st Edition, 1980.
2. McCormick BW, —Aerodynamics, Aeronautics and Flight Mechanics‖ John Wiley, 1st Edition, 1995.
3. Gupta L, —Helicopter Engineering‖, Himalayan Books, 1st Edition, 1996.

AE611PE: ADVANCED SOLID MECHANICS (PE – I)

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

Pre-Requisites: Theory of Structures

Course Objectives:

- Understand the theory of elasticity including stress strain/displacement and Hooke‘s law relationships.
- Analyze solid mechanics problems using classical methods and energy methods.
- Solve for stresses and deflections of beams under unsymmetrical loading and axisymmetric loading.
- Locate the shear center of thin wall beams and obtain stresses and deflections of beams on elastic foundations.

Course Outcomes: To Learn:

- Fracture mechanism
- Technique to solve complex structure

UNIT - I

Traction and Stresses: Concept of traction, Cauchy‘s stress theorem, postulate of Cauchy stress tensor, traction on arbitrary planes, extreme normal and shear traction, octahedral shear stress, and other stress measure – engineering stress.

UNIT - II

Axisymmetric Analysis: Introduction, thick walled cylinder subjected to internal and external pressures – lame‘s problem. Stress in composite tubes- shrink fits, sphere with purely radial displacements, stresses due to gravitation, rotating disks of uniform thickness, disks of variable thickness, rotating shafts and cylinders.

UNIT - III

Bending of Curved Beams: Winkler- Bach formula, elasticity solution for: pure bending of curved beams, curved cantilever under end loading. Beams on elastic foundation, Derivation of the basic governing equation, solution to beam on an elastic foundation subjected to a point load at the center moment at the center, Udl over some length asymmetrically about the center

UNIT - IV

Fracture Mechanics Classes: Brittle fracture, stress intensity factor, fracture toughness, fracture conditions, fracture modes, plane stress and plane strain, plastic collapse at a notch, experimental determination of KIC, strain-energy release rate, elasto-plastic fracture mechanics, Green‘s theorem.

UNIT - V

Theories of Failure: Introduction, theories of failure, significance of the theories of failure, use of factor of safety in design, a note on the use of factor of safety, Mohr‘s theory of failure.

TEXT BOOKS:

1. L. S. Srinath, —Advanced Mechanics of Solids‖, Tata McGraw-Hill, New Delhi, 2009.
2. P. Raymond, —Solid Mechanics in Engineering‖, Willey, 2001.

REFERENCE BOOKS:

1. M.H. Sadd, —Elasticity: Theory, Applications, and Numerics ‖, Academic Press, 2nd Edition, 2009.

2. R.G. Budynas, —Advanced Strength and Applied Stress Analysis‖, McGraw Hill, 3rd Edition, 1999.
3. A.P. Boresi, R.J. Schmidt, —Advanced Mechanics of Materials‖, John Willey & Sons, 6th Edition, 2003.

AE612PE: DESIGN AND ANALYSIS OF COMPOSITE STRUCTURES (PE – I)

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

Pre-Requisites: Theory of Structures

Course Objectives:

- Understand the fabrication, analysis and design of composite materials & structures.
- Explain basic composites technology, including materials and processes, manufacturing, structural design, maintenance, proof of structures and other considerations.
- Identify the static testing procedure and repairing methodology of composite structural members and joints.
- Enrich to develop structural designs using composite materials.

Course Outcomes:

- Design of composite material
- Technique to solve and repair composite structure

UNIT - I

Stress Strain Relation: Introduction- Advantages and application of composite materials, reinforcements and matrices; Generalized Hooke‘s Law; Elastic constants for anisotropic, orthotropic and isotropic materials.

UNIT - II

Methods of Analysis: Micro mechanics: Mechanics of materials approach, elasticity approach to determine material properties; Macro Mechanics; Stress-strain relations with respect to natural axis, arbitrary axis; Determination of material properties; Experimental characterization of lamina.

UNIT - III

Laminated Plates, Sandwich Constructions and Fabrication Process: Governing differential equation for a general laminate, angle ply and cross ply laminates; Failure criteria for composites. Basic design concepts of sandwich construction; Materials used for sandwich construction; Failure modes of sandwich panels; Various open and closed mould processes; Manufacture of fibers; Types of resins and properties and applications; Netting analysis.

UNIT - IV

Damage Tolerance In Composites: Introduction, sources of damage, types of damage, FAR requirements and advisory circulars, building block approach; Impact damages: Damage growth under fatigue loads; residual strength: Tests and analytical methods; Detailed design: Basics of projections, drawing standards and conventions, introduction to CADD, design of composite parts and assembly design; Optimization: Fundamentals of optimization, mathematical concepts in optimization, Optimization of composite plates.

UNIT - V

TESTING OF COMPOSITE STRUCTURES: Factors influencing testing, test environment, test methods and standards, introduction to static testing of composite structures and examples; Repair of composite aircraft structures: Introduction to repair, repair philosophy, repair sequence, repair criteria, damage assessment, classification of repair, selection of repair joints, repair procedures, certification of repair.

TEXT BOOKS:

1. Gibson, R. F, —Principles of Composite Material Mechanics‖, CRC Press, 2nd Edition, 2007.

2. Jones, R.M, Taylor & Francis, —Mechanics of Composite Materials‖, 2nd Edition, 2010 (Indian Print).
3. Reddy, J.N., —Mechanics of Laminated Composite Plates and Shells – Theory and Analysis‖, CRC Press, 2nd Edition, 2004.

REFERENCE BOOKS:

1. Agarwal, B.D., and Broutman, L.J., —Analysis and Performance of Fibre Composites‖, John Wiley and sons. Inc., New York, 1995.
2. Lubin, G., —Handbook on Advanced Plastics and Fibre Glass‖, Von Nostrand Reinhold Co., New York, 1989.
3. Autar K. Kaw —Mechanics of Composite Materials‖, 2nd Edition, CRC Press, 2005.

AE613PE: UNMANNED AIR VEHICLES (PE – I)

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

Pre-Requisites: Low speed aerodynamics, helicopter aerodynamics

Course Objectives:

- Introduce to the student about the basic ideas of Unmanned Air Vehicles.
- Familiarize the students about the aerodynamics and airframe configurations.
- Accustom the student to the wide variety of unmanned air vehicles.
- Acquaint the student about the various communication and navigation systems of unmanned air vehicles.

Course Outcomes:

- Types of UAV configuration
- Working principles of UAV, Stability and control and avionics system of UAV

UNIT - I

Introduction to Unmanned Aircraft Systems: The systemic basis of UAS-system composition; Conceptual phase; Preliminary design; Selection of the system; Some applications of UAS.

UNIT - II

Aerodynamics and Airframe Configurations: Lift-induced Drag; Parasitic Drag; Rotary-wing aerodynamics; Response to air turbulence; Airframe configurations scale effects; Packaging density; Aerodynamics; Structures and mechanisms; Selection of power-plants; Modular construction; Ancillary equipment.

UNIT - III

Characteristics of Aircraft Types: Long-endurance, long-range role aircraft; Medium-range, tactical aircraft; Close-range / battlefield aircraft; MUAV types; MAV and NAV types; UCAV; Novel hybrid aircraft configurations; Research UAV.

UNIT - IV

Communications Navigation: Communication media; Radio communication; Mid-air collision (MAC) avoidance; communications data rate and bandwidth usage; Antenna Types NAVSTAR Global Positioning System (GPS) - TACAN - LORAN C - Inertial Navigation - Radio Tracking - Way-point Navigation.

UNIT - V

Control and Stability: HTOL Aircraft - Helicopters - OTE/OTE/SPH - Convertible Rotor Aircraft - Payload Control -Sensors –culmon filter- Autonomy.

TEXT BOOKS:

1. Reg Austin., Unmanned Aircraft Systems, John Wiley and Sons., 2010.

REFERENCE BOOKS:

1. Milman & Halkias, —Integrated Electronicsǁ, McGraw Hill, 1999.
2. Malvino & Leach, —Digital Principles & Applicationsǁ, McGraw Hill, 1986.
3. Collinson R.P.G, —Introduction to Avionicsǁ, Chapman and Hall, India, 1996.
4. Bernad Etikin, "Dynamic of flight stability and controlǁ, John Wiley, 1972.

AE604PC: AIRCRAFT DESIGN

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

Pre-Requisites:

- Low Speed Aerodynamics & High-speed Aerodynamics

Course Objectives:

- Understand the basic skills involved in weight estimation for aircraft conceptual design process.
- Illustrate relevant theoretical knowledge, applicable for initial sizing and configuration layout of aircraft.
- Evaluate basic techniques in literature retrieval and query, also creative and have systematic scientific research methods and working abilities

Course Outcomes:

- Design of aircraft for various application, Effort estimation, Development life cycle

UNIT - I

Overview of The Design Process: Phases of aircraft design, aircraft conceptual design process, project brief / request for proposal, problem definition, information retrieval, integrated product development and aircraft design. initial conceptual sketches, takeoff gross weight estimation, airfoil selection, airfoil design, airfoil design considerations, wing geometry and wing vertical location, wing tip shapes, tail geometry and arrangements, thrust to weight ratio, thrust matching, wing loading performance, constraint analysis.

UNIT - II

Initial Sizing and Configuration Layout: Sizing with fixed engine and with rubber engine. geometry sizing of fuselage, wing, tail, control surfaces, development of configuration lay out from conceptual sketch. the inboard profile drawing, lofting- definition, significance and methods, flat wrap lofting, special consideration in configuration lay out, Isobar tailoring, Sears-Haack volume distribution, structural load paths, radar, IR, visual detectability, aural signature, considerations of vulnerability, crashworthiness, producibility, maintainability, fuselage design, crew station, passengers and payload

UNIT - III

Propulsion, Fuel System Integration, Landing Gear and Baseline Design Analysis – I: Propulsion selection, jet engine integration, propeller engine integration, engine design considerations, engine size estimation, fuel system design and integration, landing gear and sub systems arrangements, guidelines and significance of design layout, report of initial specifications. Estimation of lift curve slope, maximum lift coefficient, complete drag build up, installed performance of an engine, installed thrust methodology, net propulsive force, part power operation, aircraft structures and loads categories, air load distribution on lifting surfaces, review of methods of structural analysis, material selection, weights and moments statistical group estimation method, centre of gravity excursion control.

UNIT - IV

Baseline Design Analysis – II: Estimation of static pitch stability, velocity stability and trim, estimation of stability and control derivatives, static lateral, directional stability and trim. estimation of aircraft dynamical characteristics, handling qualities, Cooper – Harper scale, relation to aircraft dynamic characteristics, performance analysis and constraint analysis– steady level flight, minimum thrust required for level flight, range and loiter endurance, steady climbing and descending flight, best angle and rate of climb, time to climb and fuel to climb, level turning flight, gliding flight, energy maneuverability

methods of optimal climb trajectories and turns, the aircraft operating envelope, take off analysis, balanced field length, landing analysis, fighter performance measures of merit, effects of wind on aircraft performance, initial technical report of baseline design analysis and evaluation, refined baseline design and report of specifications.

UNIT - V

Cost Estimation, Parametric Analysis, Optimisation, Refined Sizing and Trade Studies: Elements of life cycle cost, cost estimating method, RDT&E and production costs, operation and maintenance costs, cost measures of merit, aircraft and airline economics, DOC and IOC, airline revenue, breakeven analysis, investment cost analysis, parametric analysis and optimization, improved conceptual sizing methods, sizing matrix plot and carpet plot, trade studies, design trades, requirement trades, growth sensitivities, multivariable design optimization methods, measures of merit, determination of final baseline design configuration, preparation of type specification report. case studies on design of DC-3 and Boeing B-707&747; General dynamics F-16, SR-71 Blackbird, Northrop-Grumman B-2 Stealth Bomber

TEXT BOOKS:

1. Daniel P. Raymer, —Aircraft Design: A Conceptual Approach‖, AIAA Educational Series, USA, 4th edition, 2006.
2. J. F. Marchman, L. R. Jenkinson, —Aircraft Design Projects for Engineering students‖, AIAA Publishers, USA, 2003.
3. Ajoy Kumar Kunda, —Aircraft Design‖, Cambridge University Press, UK, 2010.

REFERENCE BOOKS:

1. E. Torenbeek, —Synthesis of Subsonic Airplane Design‖, Delft University Press, New York, 1986.
2. E. H Bruhn, —Analysis and Design of Flight Vehicles Structures‖, Jacobs Publishing House, USA, New Edition, 1973.
3. E. E Scheler, L.G Dunn, —Airplane Structural Analysis and Design‖, John Wiley & Sons, USA, 1963.
4. D. Howe, —Aircraft conceptual Design Synthesis‖, John Wiley and Sons Publishers, USA, 2005.

AE605PC: AEROSPACE PROPULSION LAB

B.Tech. III Year AE II Sem.	L	T/P/D	C
	0	0/2/0	1

Pre-Requisites:

- Thermodynamics
- Aircraft propulsion

Course Objectives:

1. Understand the basics of propulsion, working principles of reciprocating engines, performance estimation based on rotation angles, and components of engine and their functions
2. Knowledge about the operation of valves, ports and their functioning in four stroke and two stroke engines.
3. Calculation of percentage of carbon residue and flash and fire point temperatures of a Lubricating Oil.
4. Understand the basic characteristics and range of performance of axial flow gas turbine. Perform parametric jet engine performance analysis and turbo machinery and basic combustion calculations.

Course Outcomes:

- Working principle of IC engine, compressor
- Turbine efficiency

LIST OF EXPERIMENTS

Week-1 ENGINE DISASSEMBLY AND ASSEMBLY

1. To understand the working mechanism and identifying various components to build an IC engine.
2. Brief description about Components of engine and their functions.

Week-2 FLASH POINT AND FIRE POINT TEST

1. Determination of flash point and fire point for a sample using pen sky martin‘s test.

Week-3 DETERMINATION OF DYNAMIC VISCOSITY OF A GIVEN SAMPLE USING REDWOOD VISCOMETER

1. Determine kinematic viscosity and dynamic viscosity of given sample using a viscometer.
2. Order fluctuating temperature is measured in terms of viscosity

Week-4 MECHANICAL EFFICIENCY OF AXIAL COMPRESSOR

1. Calculation of the Mechanical efficiency of axial compressor- power required, power Available, Compression Ratio.

Week-5 GAS TURBINE PARAMETERS CALCULATION

1. Calculation of work, power and Thrust requirement in gas turbine- combustion power input, work heat relationship.

Week-6 GAS TURBINE EFFICIENCY AND PERFORMANCE DIAGRAMS

1. Elucidate T-S, H-S diagrams for the gas turbine and compare efficiencies of non-ideal engine components.

Week-7 GAS TURBINE EFFICIENCY CALCULATIONS

1. Calculation of thermal, propulsive and overall efficiency of turbo jet cycle.

Week-8 WORK OUTPUT OF AXIAL TURBINE

1. Calculation of total work output of axial turbine- out put work necessary, Available output.

Week-9 NOZZLE PERFORMANCE

1. Calculation of various nozzle performance with airflow

Week-10 CALORIFIC VALUE OF DIFFERENT FUELS

1. Calculation of calorific value of different fuels and materials using digital bomb calorimeter and optimizing astute fuels

Week-11 FREE AND FORCED CONVECTION

1. Estimation of convection coefficient of air using forced jet or free convection apparatus

Week-12 PROPELLER TEST RIG

1. Calculation of propeller efficiency and thrust availability using propeller test rig at various blade pitch angles.

REFERENCE BOOKS:

1. https://www.cast-safety.org/pdf/3_engine_fundamentals.pdf
2. https://en.wikipedia.org/wiki/Reciprocating_engine

AE606PC: CFD LAB

B.Tech. III Year AE II Sem.	L	T/P/D	C
	0	0/2/0	1

Pre-Requisites:

- Computer Aided Aircraft Engineering Drawing
- Computational Aerodynamics

Course Objectives:

- Experience in computing aerodynamic problems and understanding flow physics over the objects.
- Knowledge in estimating flow analysis for different mach numbers.
- Determining the aerodynamic forces like mainly lift and drag.
- Analyze the errors and cause of errors in computational analysis.

Course Outcomes:

- Numerical Simulation of Aerodynamic problem
- Hands on experience on various solving technique with boundary conditions

LIST OF EXPERIMENTS

Week-1: INTRODUCTION
Introduction to computational aerodynamics, the major theories, approaches and methodologies used in computational aerodynamics. Applications of computational aerodynamics for classical aerodynamic‘s problems.

Week-2: INTRODUCTION TO GAMBIT
Introduction to gambit, geometry creation, suitable meshing types and boundary conditions.

Week-3: INTRODUCTION TO FLUENT
Introduction to fluent, boundary conditions, solver conditions and post processing results.

Week-4: FLOW OVER A FLAT PLATE
Flow over a flat plate at low Reynolds numbers, observe the boundary layer phenomena, no slip condition and velocity profile inside the boundary layer.

Week-5: FLOW THROUGH PIPE
Flow through pipe at different Reynolds numbers; observe the velocity changes for laminar and turbulent flows.

Week-6: FLOW OVER A CIRCULAR CYLINDER
Flow over a circular cylinder at different Reynolds numbers, observe the properties at separation region and wake region.

Week-7: FLOW OVER A CAMBERED AEROFOIL
Flow over a cambered aerofoil at different velocities, observe flow properties and compare the computation results with experimental results (consider the model from aerodynamics laboratory).

Week-8: FLOW OVER A SYMMETRIC AEROFOIL
Flow over a symmetric aerofoil at different velocities, observe flow properties and compare the computation results with experimental results (consider the model from aerodynamics laboratory).

Week-9: FLOW OVER WEDGE

Flow over wedge body at supersonic mach number; observe the shock wave phenomena and change of properties across the shock wave.

Week-10: FLOW OVER A CONE

Flow over a cone at supersonic mach number; observe the shock waves and 3D relieving effect.

Week-11: CODE DEVELOPMENT

Solution for the following equations using finite difference method

I. One dimensional wave equation using explicit method of lax.

II. One dimensional heat conduction equation using explicit method.

Week-12: CODE DEVELOPMENT

Generation of the following grids

I. Algebraic grids.

II. Elliptic grids.

REFERENCE BOOKS:

1. Anderson, J.D., Jr., Computational Fluid Dynamics The Basics with Applications, McGraw-Hill Inc, 1st Edition 1998.
2. Hoffmann, K. A. and Chiang, S. T., —Computational Fluid Dynamics for Engineers‖, 4th Edition, Engineering Education Systems (2000).
3. Hirsch, C., —Numerical Computation of Internal and External Flows: The Fundamentals of Computational Fluid Dynamics‖, Vol. I, 2nd Edition., Butterworth-Heinemann (2007).
4. JAF. Thompson, Bharat K. Soni, Nigel P. Weatherill —Grid generation‖, 1st Edition 2000.

EN608HS: ADVANCED COMMUNICATION SKILLS LAB

B.Tech. III Year AE II Sem.	L	T/P/D	C
	0	0/2/0	1

1. INTRODUCTION:

The introduction of the Advanced Communication Skills Lab is considered essential at 3rd year level. At this stage, the students need to prepare themselves for their careers which may require them to listen to, read, speak and write in English both for their professional and interpersonal communication in the globalized context.

The proposed course should be a laboratory course to enable students to use 'good' English and perform the following:

- Gathering ideas and information to organize ideas relevantly and coherently.
- Engaging in debates.
- Participating in group discussions.
- Facing interviews.
- Writing project/research reports/technical reports.
- Making oral presentations.
- Writing formal letters.
- Transferring information from non-verbal to verbal texts and vice-versa.
- Taking part in social and professional communication.

2. OBJECTIVES:

This Lab focuses on using multi-media instruction for language development to meet the following targets:

- To improve the students' fluency in English, through a well-developed vocabulary and enable them to listen to English spoken at normal conversational speed by educated English speakers and respond appropriately in different socio-cultural and professional contexts.
- Further, they would be required to communicate their ideas relevantly and coherently in writing.
- To prepare all the students for their placements.

3. SYLLABUS:

The following course content to conduct the activities is prescribed for the Advanced English Communication Skills (AECS) Lab:

1. **Activities on Fundamentals of Inter-personal Communication and Building Vocabulary** - Starting a conversation – responding appropriately and relevantly – using the right body language – Role Play in different situations & Discourse Skills- using visuals - Synonyms and antonyms, word roots, one-word substitutes, prefixes and suffixes, study of word origin, business vocabulary, analogy, idioms and phrases, collocations & usage of vocabulary.
2. **Activities on Reading Comprehension** –General Vs Local comprehension, reading for facts, guessing meanings from context, scanning, skimming, inferring meaning, critical reading& effective googling.
3. **Activities on Writing Skills** – Structure and presentation of different types of writing – *letter writing/Resume writing/ e-correspondence/Technical report writing/* – planning for writing – improving one's writing.
4. **Activities on Presentation Skills** – Oral presentations (individual and group) through JAM sessions/seminars/**PPTs** and written presentations through posters/projects/reports/ e-mails/assignments etc.
5. **Activities on Group Discussion and Interview Skills** – Dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and organization of ideas and rubrics for evaluation- Concept and process, pre-interview planning, opening strategies, answering strategies, interview through tele-conference & video-conference and Mock Interviews.

4. MINIMUM REQUIREMENT:

The Advanced English Communication Skills (AECS) Laboratory shall have the following infrastructural facilities to accommodate at least 35 students in the lab:

- Spacious room with appropriate acoustics.
- Round Tables with movable chairs
- Audio-visual aids
- LCD Projector
- Public Address system
- P – IV Processor, Hard Disk – 80 GB, RAM–512 MB Minimum, Speed – 2.8 GHZ
- T. V, a digital stereo & Camcorder
- Headphones of High quality

5. SUGGESTED SOFTWARE:

The software consisting of the prescribed topics elaborated above should be procured and used.

- Oxford Advanced Learner's Compass, 7th Edition
- DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice.
- Lingua TOEFL CBT Insider, by Dream tech
- TOEFL & GRE (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS)

TEXT BOOKS:

1. Effective Technical Communication by M Asharaf Rizvi. McGraw Hill Education (India) Pvt. Ltd. 2nd Edition
2. Academic Writing: A Handbook for International Students by Stephen Bailey, Routledge, 5th Edition.

REFERENCES:

1. Learn Correct English – A Book of Grammar, Usage and Composition by Shiv K. Kumar and Hemalatha Nagarajan. Pearson 2007
2. Professional Communication by Aruna Koneru, McGraw Hill Education (India) Pvt. Ltd, 2016.
3. Technical Communication by Meenakshi Raman & Sangeeta Sharma, Oxford University Press 2009.
4. Technical Communication by Paul V. Anderson. 2007. Cengage Learning pvt. Ltd. New Delhi.
5. English Vocabulary in Use series, Cambridge University Press 2008.
6. Handbook for Technical Communication by David A. McMurrey & Joanne Buckley. 2012. Cengage Learning.
7. Communication Skills by Leena Sen, PHI Learning Pvt Ltd., New Delhi, 2009.
8. Job Hunting by Colm Downes, Cambridge University Press 2008.
9. English for Technical Communication for Engineering Students, Aysha Vishwamohan, Tata Mc Graw-Hill 2009.

*MC609: ENVIRONMENTAL SCIENCE

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

Course Objectives:

- Understanding the importance of ecological balance for sustainable development.
- Understanding the impacts of developmental activities and mitigation measures
- Understanding the environmental policies and regulations

Course Outcomes:

Based on this course, the Engineering graduate will understand /evaluate / develop technologies on the basis of ecological principles and environmental regulations which in turn helps in sustainable development

UNIT - I

Ecosystems: Definition, Scope and Importance of ecosystem. Classification, structure, and function of an ecosystem, Food chains, food webs, and ecological pyramids. Flow of energy, Biogeochemical cycles, Bioaccumulation, Biomagnification, ecosystem value, services and carrying capacity, Field visits.

UNIT - II

Natural Resources: Classification of Resources: Living and Non-Living resources, **water resources:** use and over utilization of surface and ground water, floods and droughts, Dams: benefits and problems. **Mineral resources:** use and exploitation, environmental effects of extracting and using mineral resources, **Land resources:** Forest resources, **Energy resources:** growing energy needs, renewable and non renewable energy sources, use of alternate energy source, case studies.

UNIT - III

Biodiversity And Biotic Resources: Introduction, Definition, genetic, species and ecosystem diversity. Value of biodiversity; consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega diversity nation, Hot spots of biodiversity. Field visit. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; conservation of biodiversity: In-Situ and Ex-situ conservation. National Biodiversity act.

UNIT - IV

Environmental Pollution and Control Technologies: Environmental Pollution: Classification of pollution, **Air Pollution:** Primary and secondary pollutants, Automobile and Industrial pollution, Ambient air quality standards. **Water pollution:** Sources and types of pollution, drinking water quality standards. **Soil Pollution:** Sources and types, Impacts of modern agriculture, degradation of soil. **Noise Pollution:** Sources and Health hazards, standards, **Solid waste:** Municipal Solid Waste management, composition and characteristics of e-Waste and its management. **Pollution control technologies:** Wastewater Treatment methods: Primary, secondary and Tertiary.

Overview of air pollution control technologies, Concepts of bioremediation. **Global Environmental Problems and Global Efforts: C**limate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS). Deforestation and desertification. International conventions / Protocols: Earth summit, Kyoto protocol, and Montréal Protocol.

UNIT - V

Environmental Policy, Legislation & EIA: Environmental Protection act, Legal aspects Air Act- 1981, Water Act, Forest Act, Wild life Act, Municipal solid waste management and handling rules, biomedical waste management and handling rules, hazardous waste management and handling rules. EIA: EIA structure, methods of baseline data acquisition. Overview on Impacts of air, water, biological and Socio-

economical aspects. Strategies for risk assessment, Concepts of Environmental Management Plan (EMP). **Towards Sustainable Future:** Concept of Sustainable Development, Population and its explosion, Crazy Consumerism, Environmental Education, Urban Sprawl, Human health, Environmental Ethics, Concept of Green Building, Ecological Foot Print, Life Cycle assessment (LCA), Low carbon life style.

TEXT BOOKS:

1. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission.
2. Environmental Studies by R. Rajagopalan, Oxford University Press.

REFERENCE BOOKS:

1. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi.
2. Environmental Engineering and science by Gilbert M. Masters and Wendell P. Ela. 2008 PHI Learning Pvt. Ltd.
3. Environmental Science by Daniel B. Botkin & Edward A. Keller, Wiley INDIA edition.
4. Environmental Studies by Anubha Kaushik, 4th Edition, New age international publishers.
5. Text book of Environmental Science and Technology - Dr. M. Anji Reddy 2007, BS Publications.