JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. TECH. AERONAUTICAL ENGINEERING
III YEAR COURSE STRUCTURE & SYLLABUS (R16)

Applicable From 2016-17 Admitted Batch

III YEAR I SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	AE501PC	High Speed Aerodynamics	4	1	0	4
2	AE502PC	Air Breathing Propulsion	4	0	0	4
3	AE503PC	Aircraft Structural Analysis	4	1	0	4
4	SM504MS	Fundamentals of Management	3	0	0	3
5		Open Elective – I	3	0	0	3
6	AE505PC	Aerodynamics and Propulsion Lab	0	0	3	2
7	AE506PC	Aerospace Structures Lab	0	0	3	2
8	AE507PC	Aero Modeling Lab	0	0	3	2
9	*MC500HS	Professional Ethics	3	0	0	0
		Total Credits	**21**	**2**	**9**	**24**

III YEAR II SEMESTER

S. No.	Course Code	Course Title	L	T	P	Credits
1	AE601PC	Aircraft Systems	4	1	0	4
2	AE602PC	Aircraft Stability and Control	4	1	0	4
3	AE603PC	Rocket and Spacecraft Propulsion	4	0	0	4
4		Professional Elective-I	3	0	0	3
5		Open Elective-II	3	0	0	3
6	AE604PC	Computational Structures Lab	0	0	3	2
7	AE605PC	Flight Dynamics and Control Lab	0	0	3	2
8	EN606HS	Advanced English Communication Skills Lab	0	0	3	2
		Total Credits	**18**	**2**	**9**	**24**

During Summer Vacation between III and IV Years: Industry Oriented Mini Project

Professional Elective

Professional Elective - I

ME611PE	Finite Element Methods
AE612PE	Experimental Aerodynamics
AE613PE	Mechanisms and Mechanical Design
AE614PE	Unmanned Air Vehicle (UAV) Systems

***Open Elective** subjects' syllabus is provided in a separate document.

***Open Elective** – Students should take Open Electives from the List of Open Electives Offered by Other Departments/Branches Only.

Ex: - A Student of Mechanical Engineering can take Open Electives from all other departments/branches except Open Electives offered by Mechanical Engineering Dept.

HIGH SPEED AERODYNAMICS

	L	T	P	C
B.Tech. III Year I Sem.				
Course Code: AE501PC	**4**	**1**	**0**	**4**

UNIT – I

One Dimensional Flows: Compressibility, Review of Fundamentals: Concepts from Fluid Mechanics, Basic Thermodynamic Relations. Velocity of sound. Mach number, flow regimes. Governing equations of inviscid compressible flow. Continuity, Momentum and Energy equations in Integral and Differential form. Stagnation conditions.

UNIT – II

Flow through Nozzles: Flow Through a nozzle: Convergent Nozzles, CD Nozzles, Exit Pressure variation vs Stagnation pressure variation. Chocked flow conditions. Normal shock. Under and over expansion conditions. Flow through diffusers, wave reflections from a free boundary. Description of supersonic wind tunnels and rocket engine. Flow with Friction, Friction choking, Flow with heat addition, Thermal choking.

UNIT - III

Oblique Shocks And Expansion Waves: Oblique shock relations. Supersonic, Mach number relations strong and weak shock solutions / Shock flow over a wedge polar. Regular reflection from a solid boundary. Intersections of shock wave. Expansion waves. Prandtl – Meyer Expansion. **Subsonic Compressible Flow Over Airfoil:** Introduction, Velocity potential equation, Transonic small perturbation equation, Prandtl-Glauert compressibility corrections, Critical Mach number, Drag divergence Mach number, Area rule, Supercritical airfoil.

UNIT – IV

Supersonic Flow: Linearized supersonic flow, Linearized supersonic flow over airfoil and wings. Shock Expansion theory. Detached shock. Axi-symmetrical flows, flow past slender bodies of revolution, conical flows, Numerical integration procedure. **HYPERSONIC FLOWS:** Qualitative aspects of hypersonic flow. Newtonian theory. Flat plate at an angle of attack. Hypersonic shock wave relations. Lift and drag of wings at hypersonic speeds. Recent advances in hypersonic flows and testing techniques.

UNIT – V

Flow Measurements and Model Testing: Non dimensional parameters and II numbers Similarity of flows. Model testing in wind tunnels. Pressure, Velocity measurements, **Force Measurements Wind Tunnel Balances:** Force measurements, Wind tunnel balances. Scale effects and corrections, wall interferences, induced drag and other computations/corrections. Experimental Methods, Shock Tube, Supersonic Wind tunnel, Flow visualization, Supersonic Probes., Methods of characteristics. Design of nozzles, External flow around bodies, Experimental characteristics of airfoils in compressible flow.

TEXT BOOKS:

1. Anderson J. D (2004), Modern Compressible Fluid Flow, 3rd Edition, McGraw-Hill International Edition, New York
2. Rathakrishnan E.E. (2010), Gas Dynamics, 3rd Edition, Prentice Hall of India, New Delhi.

REFERENCE BOOKS:

1. Anderson J .D. (2011), Fundamental of Aerodynamics, 5th edition, McGraw-Hill, New Delhi. Hodge B. K, Koenig K (1995), Compressible Fluid Dynamics with Computer Application, 1st edition, Prentice Hall, New York.
2. Clancy L. J. (2006), *Aerodynamics*, Sterling Publishers, New Delhi.

AIRBREATHING PROPULSION

	L	T	P	C
B.Tech. III Year I Sem.				
Course Code: AE502PC	**4**	**0**	**0**	**4**

UNIT - I

Gas Turbine Theories: Impulse and reaction balding of gas turbines, Velocity triangles and power output, Elementary theory, Vortex theory. Choice of blade profile, pitch and chord, Estimation of stage performance.

Design Consilretions: Limiting factors in gas turbine design, Overall turbine performance. Methods of blade cooling, matching of turbine and compressor, Numerical problems.

UNIT - II

Thrust Control: Thrust Augmentation through after burning, thrust vector control methods.

RAMJET Propulsion: Operating principle Subcritical, critical and supercritical operation. Combustion in ramjet engine, Ramjet performance, Sample ramjet design calculations. Introduction to SCRAMJET, Preliminary concepts in supersonic combustion, Integral ram, Rocket, Numerical problems.

UNIT - III

Chemical Rockets: *Solid Propellant:* Solid propellant rockets, Selection criteria of solid propellants, important hardware components of solid rockets, Propellant grain design considerations.

Liquid Propellant: Liquid propellant rockets, cooling in liquid rockets. Limitations of hybrid rockets, Relative advantages of liquid rockets over solid rockets.

UNIT - IV

Fundamentals of Rocket Propulsion: Operating principle, Specific impulse of a rocket, internal ballistics, Rocket nozzle classifications. Rocket performance considerations, Numerical problems.

UNIT - V

Advanced Propulsion Techniques: Electric rocket propulsion, Ion propulsion techniques, nuclear rocket - Types, Solar sail, and Preliminary concepts in nozzle less propulsion.

TEXT BOOKS:

1. Sutton G. P. (2010), *Rocket Propulsion Elements*, 8th edition, John Wiley & Sons Inc, USA.
2. Philipa Hill, Carl Peterson (2010), *Mechanics and Thermodynamics of Propulsion*, 2nd edition, Addison Wesley Longman Inc, USA.

REFERENCE BOOKS:

1. Oates G. C (1986), *Aero Thermodyanamics of Aircraft Engine Components*, AIAA Educational Series, USA.

2. Rolls- Royce (2005), *Jet Engine*, 6th edition, Rolls - Royce Ltd, USA.
3. Ganesan V (2010), *Gas Turbines*, Tata McGraw- Hill, New Delhi.
4. S. M. Yahya(2010), *Fundamentals of Compressible Flow with Aircraft and Rocket propulsion*, 4th Edition, New Age International Publications, New Delhi.

AIRCRAFT STRUCTURAL ANALYSIS

B.Tech. III Year I Sem.	**L**	**T**	**P**	**C**
Course Code: AE503PC	**4**	**1**	**0**	**4**

UNIT - I

Thin Plate Theory, Structural Instability: Analysis of thin rectangular plates subject to bending, twisting, distributed transverse load, combined bending and in-plane loading- thin plates having small initial curvature, energy methods of analysis. Buckling of thin plates- elastic, inelastic, experimental determination of critical load for a flat plate, local instability, Tension field beams- complete diagonal tension, incomplete diagonal tension.

UNIT - II

Bending, Shear and Torsion of Thin Walled Beams: Unsymmetrical bending- resolution of bending moments, direct stress distribution, position of neutral axis. Deflections due to bending- approximations for thin walled sections, temperature effects. Shear loaded thin walled beams- general stress, strain and displacement relationships- direct stress - shear centre, twist and warping. Torsion of beams of closed section- displacements associated with Bredt-Batho shear flow. Torsion of open section beams. Warping of cross section- conditions for zero warping. Bending, shear, torsion of combined open and closed section beams.

UNIT - III

Structural Idealisation of Thin Walled Beams: Structural idealization- principal assumptions, idealization of panel, effect on the analysis of thin walled beams under bending, shear, torsion loading- application to determining deflection.

UNIT - IV

Structural and Loading Discontinuities in Thin Walled Beams: Closed section beams- shear stress distribution of a closed section beam built in at one end under bending, shear and torsion loads.

Open section beams- I section beam subjected to torsion, torsion of beam of arbitrary section, torsion bending constant, distributed torque loading- extension of theory for general systems of loading. Shear lag- effect of shearing strains in beams- redistribution of bending stresses due to restraining of warping, limitation of elementary bending theory, effect of accounting for shear lag on the estimated strength.

UNIT - V

Stress Analysis of Aircraft Components- Wing, Fuselage: Wing spars and box beams- tapered wing spar, open and closed section beams, beams having variable stringer areas. Wings- Three-boom shell in bending, torsion, shear, tapered wings, deflections, cut-outs in wings. Bending, shear, torsion, cut-outs in fuselages. Fuselage frames and wing ribs- principles of stiffener/ web construction, fuselage frames, wing ribs.

TEXT BOOKS:

1. Megson, T.H.G., Aircraft Structures for Engineering Students, 4th edn., Elsevier, 2007, ISBN 0-750-667397.
2. Peery, D.J. and Azar, J.J., Aircraft Structures, 2nd edn., McGra-Hill, 1982, ISBN 0-07-049196-8.

REFERENCES:

1. Allen, D.H. and Haisler, W.E., *Introduction to Aerospace Structural Analysis*, John Wiley, 2010.
2. Bruhn. E.H, *Analysis and Design of Flight Vehicles Structures*, Tri-state Off-set Company, USA, 1965.
3. Lakshmi Narasaiah, G., *Aircraft Structures*, BS Publications, 2010.
4. Sechler.E.E. and Dunn, L.G., *Airplane Structural Analysis and Design*, John Wiley & Sons, 1942

FUNDAMENTALS OF MANAGEMENT

B.Tech. III Year I Sem.	**L**	**T**	**P**	**C**
Course Code: SM504MS	**3**	**0**	**0**	**3**

Course Objectives: To understand the Management Concepts, applications of Concepts in Practical aspects of business and development of Managerial Skills.

Course Outcomes: The students understand the significance of Management in their Profession. The various Management Functions like Planning, Organizing, Staffing, Leading, Motivation, and Control aspects are learnt in this course. The students can explore the Management Practices in their domain area.

UNIT - I

Introduction to Management: Definition, Nature and Scope, Functions, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management; Evolution of Management- Classical Approach- Scientific and Administrative Management; The Behavioral approach; The Quantitative approach; The Systems Approach; Contingency Approach, IT Approach.

UNIT – II

Planning and Decision Making: General Framework for Planning - Planning Process, Types of Plans, Management by Objectives; Development of Business Strategy. Decision making and Problem Solving - Programmed and Non Programmed Decisions, Steps in Problem Solving and Decision Making; Bounded Rationality and Influences on Decision Making; Group Problem Solving and Decision Making, Creativity and Innovation in Managerial Work.

UNIT - III

Organization and HRM: Principles of Organization: Organizational Design & Organizational Structures; Departmentalization, Delegation; Empowerment, Centralization, Decentralization, Recentralization; Organizational Culture; Organizational Climate and Organizational Change.

Human Resource Management & Business Strategy: Talent Management, Talent Management Models and Strategic Human Resource Planning; Recruitment and Selection; Training and Development; Performance Appraisal.

UNIT - IV

Leading and Motivation: Leadership, Power and Authority, Leadership Styles; Behavioral Leadership, Situational Leadership, Leadership Skills, Leader as Mentor and Coach, Leadership during adversity and Crisis; Handling Employee and Customer Complaints, Team Leadership.

Motivation - Types of Motivation; Relationship between Motivation, Performance and Engagement, Content Motivational Theories - Needs Hierarchy Theory, Two Factor Theory, Theory X and Theory Y.

UNIT - V

Controlling: Control, Types and Strategies for Control, Steps in Control Process, Budgetary and Non- Budgetary Controls. Characteristics of Effective Controls, Establishing control systems, Control frequency, and Methods.

TEXT BOOKS:

1. Management Fundamentals, Robert N Lussier, 5e, Cengage Learning, 2013.
2. Fundamentals of Management, Stephen P.Robbins, Pearson Education, 2009.

REFERENCES:

1. Essentials of Management, Koontz Kleihrich, Tata Mc - Graw Hill.
2. Management Essentials, Andrew DuBrin, 9e, Cengage Learning, 2012.

AERODYNAMICS AND PROPULSION LAB

B.Tech. III Year I Sem.	**L**	**T**	**P**	**C**
Course Code: AE505PC	**0**	**0**	**3**	**2**

LIST OF EXPERIMENTS:

1. Calibration of subsonic wind tunnel.
2. Pressure distribution over smooth and rough cylinder.
3. Pressure distribution over symmetric airfoil.
4. Pressure distribution over cambered airfoils.
5. Pressure distribution over thin airfoils.
6. Force measurement using wind tunnel balance.
7. Flow over a flat plate at various angles of incidence.
8. Flow visualization studies in low speed over cylinder.
9. Flow visualization studies in low speed over wedge.
10. Flow visualization studies in low speed over airfoil at different angles of incidence.

REFERENCES:

1. Clancy. L. J, "Aerodynamics", Pitman, 1st Edition, 1986.
2. Milne L.H, Thomoson, "Theoretical Aerodynamics", Dover, 2nd Edition, 1985.
3. N. M. Komerath, "Low Speed Aerodynamics", Extrovert, 1st Edition, 2012.

AEROSPACE STRUCTURES LAB

	L	T	P	C
B.Tech. III Year I Sem.				
Course Code: AE506PC	**0**	**0**	**3**	**2**

LIST OF EXPERIMENTS:

1. Study of construction and use of Universal Testing Machine, mechanical and optical
2. Extensometers- application to determine stress-strain curves and tensile and compressive
3. Strength of various engineering materials.
4. 2. Bending tests- deflection of slender and short beams for various loading and end conditions determination of influence coefficients- verification of Maxwell's and Castiglione's theorems.
5. Compression tests on long and short columns- determination of buckling loads- South well plot.
6. Determination of the strength and deformation of riveted and bolted joints.
7. Methods of inspection and non-destructive testing (NDT) of aircraft structural components.
8. Strain gauge techniques- measurement of strain in beams, thin and thick walled cylinders
9. Subjected to internal pressure, shaft subjected to combined loading.
10. Shear Centers of open and closed sections- determination of the elastic axis of beams.
11. Post buckling behaviour of shear panels- measurements on semi-tension field webs of beams.
12. Determination of elastic constants of composite materials- flexural test on composites.
13. Study and calibration of photo and magnetic speed pickups for the measurement of speed.
14. Study and use of seismic pickups for the measurement of amplitude and frequency of vibration of structural components.
15. Determination of critical fracture toughness of aerospace materials.

REFERENCE BOOKS:

1. Megson, T.H.G., Aircraft Structures for Engineering Students, 4th edn., Elsevier, 2007, ISBN 0-750-667397.
2. Bruhn. E.H, Analysis and Design of Flight Vehicles Structures, Tri-state of Off-set Company, USA, 1965.

AEROMODELING LAB

	L	T	P	C
B.Tech. III Year I Sem.				
Course Code: AE507PC	**0**	**0**	**3**	**2**

Design and Modelling of Aircraft Components Using CATIA:

1. Design of airfoils and wings
2. Design of fuselage with seating arrangement
3. Design of propeller shaft and blades
4. Design of landing gear
5. Design of horizontal and vertical stabilizer
6. Design of nose cone
7. Design of door of aircraft

Assembly and Modelling of the Aircraft Components Using PRO-E:

1. Assemble the wings to fuselage
2. Assemble the seating arrangement in fuselage
3. Assemble the engine along with propeller shaft and blades in fuselage
4. Assemble the landing gears to fuselage
5. Assemble the horizontal and vertical to fuselage
6. Assemble the door to fuselage

PROFESSIONAL ETHICS

B.Tech. III Year I Sem.	**L**	**T**	**P**	**C**
Course Code: MC500HS	**3**	**0**	**0**	**0**

Course Objective: To enable the students to imbibe and internalize the Values and Ethical Behavior in the personal and Professional lives.

Course Outcome: The students will understand the importance of Values and Ethics in their personal lives and professional careers. The students will learn the rights and responsibilities as an employee, team member and a global citizen.

UNIT - I

Introduction to Professional Ethics: Basic Concepts, Governing Ethics, Personal & Professional Ethics, Ethical Dilemmas, Life Skills, Emotional Intelligence, Thoughts of Ethics, Value Education, Dimensions of Ethics, Profession and professionalism, Professional Associations, Professional Risks, Professional Accountabilities, Professional Success, Ethics and Profession.

UNIT - II

Basic Theories: Basic Ethical Principles, Moral Developments, Deontology, Utilitarianism, Virtue Theory, Rights Theory, Casuist Theory, Moral Absolution, Moral Rationalism, Moral Pluralism, Ethical Egoism, Feminist Consequentialism, Moral Issues, Moral Dilemmas, Moral Autonomy.

UNIT - III

Professional Practices in Engineering: Professions and Norms of Professional Conduct, Norms of Professional Conduct vs. Profession; Responsibilities, Obligations and Moral Values in Professional Ethics, Professional codes of ethics, the limits of predictability and responsibilities of the engineering profession.

Central Responsibilities of Engineers - The Centrality of Responsibilities of Professional Ethics; lessons from 1979 American Airlines DC-10 Crash and Kansas City Hyatt Regency Walk away Collapse.

UNIT - IV

Work Place Rights & Responsibilities, Ethics in changing domains of Research, Engineers and Managers; Organizational Complaint Procedure, difference of Professional Judgment within the Nuclear Regulatory Commission (NRC), the Hanford Nuclear Reservation.

Ethics in changing domains of research - The US government wide definition of research misconduct, research misconduct distinguished from mistakes and errors, recent history of attention to research misconduct, the emerging emphasis on understanding and fostering responsible conduct, responsible authorship, reviewing & editing.

UNIT - V

Global issues in Professional Ethics: Introduction – Current Scenario, Technology Globalization of MNCs, International Trade, World Summits, Issues, Business Ethics and Corporate Governance, Sustainable Development Ecosystem, Energy Concerns, Ozone Deflection, Pollution, Ethics in Manufacturing and Marketing, Media Ethics; War Ethics; Bio Ethics, Intellectual Property Rights.

TEXT BOOKS:

1. Professional Ethics: R. Subramanian, Oxford University Press, 2015.
2. Ethics in Engineering Practice & Research, Caroline Whitbeck, 2e, Cambridge University Press 2015.

REFERENCES

1. Engineering Ethics, Concepts Cases: Charles E Harris Jr., Michael S Pritchard, Michael J Rabins, 4e , Cengage learning, 2015.
2. Business Ethics concepts & Cases: Manuel G Velasquez, 6e, PHI, 2008.

AIRCRAFT SYSTEMS

	L	T	P	C
B.Tech. III Year II Sem.				
Course Code: AE601PC	**4**	**1**	**0**	**4**

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 Flight Control 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) cyclo converter and 270 V DC systems.

Flight control systems: primary and secondary flight control, control linkages, actuation-types, description, and redundancy; Fly-by-wire control- control laws, implementation.

UNIT - III

Hydraulic Systems: Aircraft hydraulic systems: function, merits, application, system loads, design requirements, Principal components; Flight control actuation- importance, need for redundancy, types, description, and applications.

Hydraulic fluid: Required properties, operating fluid pressures, temperatures, and flow rates; Hydraulic piping, pumps, reservoir, accumulator; Landing gear and brake management systems.

UNIT - IV

Pneumatic and Environmental Control Systems: Engine as source of high pressure air-engine bleed air- user systems, environment control, windscreen, wing and engine anti-ice, engine start, hydraulic, Pitot-static systems; Bleed air control- structure, components, operation; Need for controlled cabin environment; Principal heat sources in aircraft; Methods of cooling- ram air, engine bleed air, fuel cooling; Cooling systems: air cycle refrigeration, types, turbo fan, bootstrap, reverse bootstrap systems; Vapor cycle refrigeration. Humidity control; Air distribution systems, cabin pressurization, molecular-sieve oxygen concentrators, g-tolerance and protection.

UNIT – V

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.

TEXT BOOKS:

1. David A Lombaro, "Aircraft systems", Tata Mc Graw Hill, 2nd Edition, 2009.
2. Moir I. Sea bridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", 3rd Edition, John Wiley, 2008.
3. Moir I. Sea bridge, "Design and Development of Aircraft Systems- an Introduction", AIAA Education Series, AIAA, 2nd Edition, 2004.

REFERENCES:

1. Pallett, E.H.J, "Aircraft Instruments and Integrated Systems", Longman Scientific and Technical, 10th Edition, 1992.
2. Harris D, "Flight Instruments and Automatic Flight Control Systems", Ground Studies for Pilots, Blackwell Science, 6th Edition, 2004.
3. Bolton W, "Pneumatic and Hydraulic Systems", Butterworth-Heinemann, 1st Edition, 1997.

AIRCRAFT STABILITY AND CONTROL

	L	T	P	C
B.Tech. III Year II Sem.				
Course Code: AE602PC	**4**	**1**	**0**	**4**

UNIT - I

INTRODUCTION: Degree Of Freedom Of A System, Static And Dynamic Stability. Need For Stability In An Airplanes. Purpose Of Controls, Inherently And Marginally Stable Airplanes.

EQUATIONS OF MOTION: Equations Of Motion Of A Rigid Body. Inertial Forces And Moments. Equations Of Motion Of Flight Vehicles. Aerodynamic Forces And Moments. Decoupling Of Longitudinal And Lateral-Directional Equations. Linearization Of Equations.

UNIT - II

AERODYNAMIC STABILITY DERIVATIVES: Aerodynamic Stability And Control Derivatives. Relation To Geometry, Flight Configuration. Effects Of Power, Compressibility, And Flexibility.

UNIT - III

STATIC LONGITUDINAL STABILITY - CONTROL FREE: Effects Of Releasing The Elevator. Hinge Moment Coefficients, Control Forces To Trim. Control Free Neutral Point - Trim Tabs. Aerodynamic Balancing Of Control Surfaces. Means Of Augmentation Of Control.

MANEUVER STABILITY: Contribution Of Pitch Damping To Pitching Moment Of Flight Vehicle, Effect On Trim And Stability. Control Deflections And Control Forces For Trim In Symmetric Maneuvers And Coordinated Turns. Control Deflection And Force Gradients. Control Fixed And Control Free Maneuver Stability. Maneuver Points. Maneuver Margins.

UNIT - IV

STATIC LONGITUDINAL STABILITY AND CONTROL - CONTROL FIXED: STICK FIXED: Basic Equilibrium Equation, Stability Criterion, Contribution Of Wing And Tail And Elevator To Pitching Moments. Effect Of Fuselage And Nacelles, Effects Of Center Of Gravity Location, Power Effects Stabilizer Setting And Center Of Gravity Location, Elevator Power, Elevator To Trim . Trim Gradients. Control Fixed Static Stability, Control Fixed Neutral Point. Stability Margins.

UNIT - V

STATIC LATERAL AND DIRECTIONAL STABILITY AND CONTROL: Dihedral Effect, Coupling Between Rolling And Yawing Moment, Adverse Yaw, Aileron Power, Aileron Reversal. Weather Cocking Effects, Rudder Power. Lateral And Directional Stability- Definition. Control Surface Deflections In Steady Sideslips, Rolls And Turns One Engine Inoperative

Conditions, Rudder Lock.

DYNAMIC STABILITY AND RESPONSE TO CONTROL: Solutions To The Stability Quadratic Of The Linearised Equations Of Motion. The Principal Modes. Phugoid , Short Period Dutch Roll And Spiral Modes, Further Approximations. Restricted Degrees Of Motion. Solutions. Response To Controls. Auto Rotation And Spin.

TEXT BOOKS:

1. Houghton E. L, Carruthers N. B. (2010), *Aerodynamics For Engineering Students*, 5th Edition, Elsevier, USA.
2. Mc. Cormic B. W. (2010), *Aerodynamics, Aeronautics And Flight Mechanics*, Wiley India Pvt. Ltd, USA.

REFERENCE BOOKS:

1. Perkins C. D, Robert Hage E (2003), *Airplane Performance, Stability And Control*, Wiley Toppan, USA.
2. Nelson R. C (2007), *Flight Stability And Automatic Control*, Sie Edition, MCGRAW Hill, New York.
3. T. R. Yechout, S. L. Morns (2003), *Introduction To Aircraft Flight Mechanics*, Aiaa Publishers, USA.

ROCKET AND SPACECRAFT PROPULSION

	L	T	P	C
B.Tech. III Year II Sem.				
Course Code: AE603PC	**4**	**0**	**0**	**4**

UNIT – I

ROCKET SYSTEMS: Ignition System In Rockets, Types Of Igniters, Igniter Design Considerations; Design Consideration Of Liquid Rocket Combustion Chamber, Injector Propellant Feed Lines, Valves, Propellant Tanks And Their Outlets; Pressurized And Turbine Feed Systems; Propellant Slosh And Propellant Hammer; Elimination Of Geysering Effect In Missiles; Combustion System Of Solid Rockets.

UNIT - II

AERODYNAMICS OF ROCKET AND MISSILES: Airframe Components Of Rockets And Missiles; Forces Acting On A Missile While Passing Through Atmosphere; Classification Of Missiles; Method Of Describing Aerodynamic Forces And Moments; Lateral Aerodynamic Moment; Lateral Damping Moment And Longitudinal Moment Of A Rocket; Lift And Drag Forces; Drag Estimation; Body Upwash And Downwash In Missiles; Rocket Dispersion; Numerical Problems.

UNIT - III

ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD: One Dimensional And Two Dimensional Rocket Motions In Free Space And Homogeneous Gravitational Fields; Description Of Vertical, Inclined And Gravity Turn Trajectories; Determination Of Range And Altitude; Simple Approximations To Burnout Velocity.

UNIT - IV

STAGING AND CONTROL OF ROCKET AND MISSILES: Rocket Vector Control, Methods, Thrust Termination; Secondary Injection Thrust Vector Control System; Multistaging Of Rockets; Vehicle Optimization; Stage Separation Dynamics; Separation Techniques.

UNIT – V

MATERIALS FOR ROCKET AND MISSILES: Selection Of Materials; Special Requirements Of Materials To Perform Under Adverse Conditions.

TEXT BOOKS:

1. Sutton, G. P., And Biblarz, O., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 8th Edition, 2010.
2. M.J. L. Turner, “Rocket And Spacecraft Propulsion”, Praxis Publishing, 2nd Edition, 2006.
3. Mathur, M., And Sharma, R.P., “Gas Turbines And Jet And Rocket Propulsion”, Standard Publishers, New Delhi, 4th Edition, 2005.P.G Hill, C.R. Peterson

4. "Mechanics & Thermodynamics Of Propulsion" Addison Wesley Longman Inc, 3rd Edition, 1991.

REFERENCES

1. Leissa, A.W., Vibration Of Continuous System, The Mcgraw-Hill Company, 2011.
2. Inman, D.J., Vibration Engineering, Third Edition, Prentice Hall Int., Inc., 2001,
3. Kelly, S.G., Schaum's Outline Of The Theory And Problems Of Mechanical Vibrations, Schaum's Outline Series, Mcgraw-Hill, 1996.

FINITE ELEMENT METHODS
(PROFESSIONAL ELECTIVE – I)

	L	T	P	C
B. Tech. III Year II Sem.				
Course Code: NT603PC/ME611PE	**3**	**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. Implement and solve the finite element formulations using MATLAB.

UNIT – I

Introduction to Finite Element Method for solving field problems. Stress and Equilibrium. Boundary conditions. Strain – Displacement relations. Stress – strain relations for 2-D and 3-D Elastic problems.

One Dimensional Problems: 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: Stiffness Matrix for Plane Truss Elements, Stress Calculations and problems. **Analysis of Beams**: Element stiffness matrix for two nodded, two degrees of freedom per node beam element and simple problems.

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 nodded Isoperimetric elements and numerical integration.

UNIT – IV

Steady State Heat Transfer Analysis: one dimensional analysis of Slab, fin and two dimensional analysis of thin plate. Analysis of a uniform shaft subjected to torsion.

UNIT – V

Dynamic Analysis: Formulation of finite element model, element - Mass matrices, evaluation of Eigen values and Eigen vectors for a stepped bar, truss. Finite element – formulation to 3 D problems in stress analysis, convergence requirements, Mesh generation, techniques such as semi automatic and fully Automatic use of software's such as ANSYS, NISA, NASTRAN, etc.

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

EXPERIMENTAL AERODYNAMICS
(PROFESSIONAL ELECTIVE – I)

	L	T	P	C
B.Tech. III Year II Sem.				
Course Code: AE612PE	**3**	**0**	**0**	**3**

UNIT – I

Aerodynamic Experiments - History, Model Testing & Wind Tunnels - Types, Application: Forms of aerodynamic experiments- observation, measurement- objectives. History means. Model testing- wind tunnel- principles - scaling laws, scale parameters- significance. Wind tunnels- low speed- types, description. High speed tunnels- transonic, supersonic, hypersonic, shock tubes, special tunnels- low turbulence, high Re, environmental, automobile- function, distinctive features, application. Major wind tunnel facilities- description, details.

UNIT - II

Low Speed Wind Tunnels - Construction, Components, Performance & Wind Tunnel Corrections: Low speed wind tunnel- principal components- working section, diffuser, corners, turning vanes, fan, straighteners, honeycombs, screens, contraction cone, fan, motor- function, description, design requirements, constraints, construction, performance- loss coefficients. Wind tunnel performance- flow quality, power losses.

Wind tunnel corrections. Sources of inaccuracies- buoyancy, solid blockage, wake blockage, streamline curvature- causes, estimation, and correction. Total correction on airspeed, dynamic pressure, and zero lift drag.

UNIT - III

Load Measurements - Wind Tunnel Balances & Flow Measurements – Instrumentation: Load measurements - wind tunnel balances, types, description, application. Steady and unsteady pressure measurements and various types of pressure probes and transducers, errors in pressure measurements; measurement of temperature using thermocouples, resistance thermometers, temperature sensitive paints and liquid crystals; measurement of airspeed, flow direction, boundary layer profile using Pitot static tubes, 5 hole probes, total head rake- function, working principle, types, details of design and construction.

UNIT - IV

Flow Visualisation Techniques: Flow visualisation- need, types- tufts, china clay, oil film, smoke- working principle, description, setting up, operation, observation, recording, interpretation of imagery, relative merits, applications. High speed flows- optical methods- shadowgraphy, Schleiren, interferometry.

UNIT – V

Measurement of Velocity - Hotwire Anemometry, Laser Doppler Anemometry, Particle Image Velocimetry- Overview: Hot Wire Anemometry, Laser Doppler Anemometry,

Particle Image Velocimetry- working principles, description of equipment, experimental setup, settings, calibration, measurement, data processing, applications.

TEXT BOOKS:

1. Low Speed Wind Tunnel Testing, Barlow, J.B., Rae, W.H., Pope, A., Wiley 1999.
2. High Speed Wind Tunnel Testing, Pope, A. and Goin, K.L., Wiley, 1965.
3. Yang, W.J., Handbook of Flow Visualization, 2nd edition, Taylor and Francis, 2001.

REFERENCES

1. 1. Bradshaw, P., Experimental Fluid Mechanics, Pergamon Press, 1970.
2. Goldstein, R.J., (Ed.) Fluid Mechanics Measurements, Taylor Francis, Washington 1996. 84.
3. Tropea, C., Yarin, A. L., Foss, J. F., Handbook of Experimental Fluid Mechanics, Springer, 2007

MECHANISMS AND MECHANICAL DESIGN
(PROFESSIONAL ELECTIVE – I)

	L	T	P	C
B.Tech. III Year II Sem.				
Course Code: AE613PE	**3**	**0**	**0**	**3**

UNIT – I

Mechanisms & Machines: Elements of links – classification – rigid link, flexible and fluid link. Types of kinematic pairs – sliding, turning, rolling, screw and spherical pairs. Lower and higher pairs, closed and open pairs. Constrained motion – Completely, partially or successfully constrained, and incompletely constrained. Mechanism and machines – classification. Kinematic chain, inversion of mechanism, inversion of quadratic cycle. Chain – single and double slider crank chains. Exact and approximate straight line mechanisms - Peaucellier, Hart T. Chibichef, Pantograph.

UNIT - II

Kinematic Analysis of Mechanisms: Velocity and acceleration. Motion of link in machine – determination of velocity and acceleration diagrams – graphical method. Application of relative velocity method for four bar chain. Analysis of slider crank chain for displacement, Velocity and acceleration of sliding – Acceleration diagram for a given mechanism, Kleins construction, Coriolis acceleration, Determination of Coriolis component of acceleration.

UNIT - III

Plane Motion of Body & Gyroscopic Motion - Precession: Instantaneous centre of rotation, centroids and axodes – Relative motion between two bodies – Three centres in line theorem – Graphical determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links. The gyroscope- free and restrained-working principle- the free gyro, rate gyro, integrating gyro as motion measuring instruments. Effect of precession on the stability of vehicles- motorbikes, automobiles, airplanes and ships. Static and dynamic forces generated due to in precession in rotating mechanisms.

UNIT - IV

Cams and Followers & Steering Gears: Cams and followers- definition uses – types– terminology. Types of follower motion- uniform velocity, simple harmonic motion and uniform acceleration. Maximum velocity and acceleration during outward and return strokes. Roller follower, circular cam with straight, concave and convex flanks. Condition for correct steering – Davis steering gear, Ackerman's steering gear– Velocity ratio, Hook's Joint– single and double Hooks joint– universal coupling– applications.

UNIT – V

Gears and Gear Trains & Design of Four Bar Mechanisms: Introduction to gears- types, law of gearing. Tooth profiles- specifications, classification- helical, bevel and worm gears, simple and reverted gear train, epicyclic gear trains- velocity ratio or train value. Four bar

mechanism, Freudenstein equation. Precession point synthesis, Chebyshev's method, structural error.

TEXT BOOKS:

1. Theory of Machines, Dr Jagdish Lal, JM Shaw.
2. Theory of Machines, Abdulla Sharif, Dhanpat Rai, 1987.
3. Theory of Machines, PL Ballaney, Khanna Publishers, 2003.

REFERENCES:

1. Theory of Machines Through Solved Problems, JS Rao / New Age – 1996
2. Mechanical engineering and design, J.E.Shigley and Charles.R.Mischke, TMH, 2003.

UNMANNED AIR VEHICLE (UAV) SYSTEMS
(PROFESSIONAL ELECTIVE – I)

	L	T	P	C
B.Tech. III Year II Sem.				
Course Code: AE614PE	**3**	**0**	**0**	**3**

UNIT - I

Introduction to Unmanned Aircraft Systems: Applications of UAS, categories of UAS systems, roles of unmanned aircraft, composition of UAV system

UNIT - II

Design of UAV Systems-I: Introduction to design and selection of the systems-conceptual phase, preliminary design, detailed design; Aerodynamics and airframe configurations-Lift-induced Drag, Parasitic Drag, Rotary-wing Aerodynamics, Response to Air Turbulence, Airframe Configurations; Medium-range, Tactical Aircraft, 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, Aspects of Airframe Design: Scale Effects, Packaging Density, Aerodynamics, Structures and Mechanisms, Selection of power- plants, Modular Construction, Ancillary Equipment, Design for Stealth: Acoustic Signature, Visual Signature, Thermal Signature, Radio/Radar Signature, Payload Types: Non-dispensable and dispensable payloads

UNIT - III

Design of UAV Systems-II: Communications-Communication Media, Radio Communication, Mid-air Collision (MAC) Avoidance, Communications Data Rate and Bandwidth Usage, Antenna Type; Control and Stability: HTOL Aircraft, Convertible Rotor Aircraft, Payload Control, Sensors, Autonomy; Navigation: NAVSTAR Global Positioning System (GPS), TACAN, LORAN C, Inertial Navigation, Radio Tracking, Way-point Navigation; Launch and Recovery; Design for Reliability: Determination of the Required Level of Reliability, Achieving Reliability, Reliability Data Presentation, Multiplexed Systems, Reliability by Design, Design for Ease of Maintenance; Design for Manufacture and Development

UNIT - IV

The Development of UAV Systems: System Development and Certification-System Development, Certification, Establishing Reliability; System Ground Testing: UAV Component Testing, UAV Sub-assembly and Sub-system Testing, Testing Complete UAV, Control Station Testing , Catapult Launch System Tests, Documentation; System In-flight Testing: Test Sites, Preparation for In-flight Testing, In-flight Testing, System Certification;

UNIT - V

Deployment and Future of UAV Systems: Operational trials and full certification; UAV System Deployment- Network-centric Operations (NCO), Teaming with Manned and Other

Unmanned System; Naval, arm and air force roles, civilian, paramilitary and commercial roles

TEXTBOOK:

1. Unmanned Aircraft Systems: UAVS Design, Development and Deployment, Reg Austin, Wiley, 2010.

REFERENCE BOOK:

1. Introduction to Unmanned Aircraft Systems, Richard K. Barnhart, Stephen B. Hottman, Douglas M. Marshall, Eric Shappee, (eds.), CRC Press, 2012.

COMPUTATIONAL STRUCTURES LAB

B.Tech. III Year II Sem.	**L**	**T**	**P**	**C**
Course Code: AE604PC	**0**	**0**	**3**	**2**

1, 2. Introduction to the features and application of any one of the professional software employed in modelling and analysis of aircraft structures.

Modeling, Analysis (Maximum Stresses, Deflections) and Code Development, Of Structural Elements under Arbitrary Static Loading - Validation of Solutions with Professional Software

3. Bending of uniform cantilever beams.

4. Compressive strength of rectangular stiffened plane panels of uniform cross-section.

5. Shear and torsion of stiffened thin walled open and closed sections.

6. Statically indeterminate trusses.

7. Free vibrations of uniform cantilever beams- determination of natural frequencies and mode shapes.

Modeling and Analysis of Simple Aircraft Components Using Professional Software

8. 3 dimensional landing gear trusses.

9. Tapered wing box beams.

10. Fuselage bulkheads.

Suggested software:

ANSYS

NASTRAN

PATRAN

FLIGHT DYNAMICS AND CONTROL LAB

B.Tech. III Year II Sem.	**L**	**T**	**P**	**C**
Course Code: AE605PC	**0**	**0**	**3**	**2**

1. BASIC ANATOMY OF AN AIRCRAFT: The main aim of this experiment is to have a control over all the control surfaces of an aircraft.

2. HELICOPTER FLIGHT: The main aim of this experiment is to understand the mechanism involved in helicopter flight. The helicopter control mechanism is not exactly the same as that of an aircraft control mechanism, one need to study the controls mechanism of helicopter in order to obtain pitch, roll, and yaw maneuver.

3. FLIGHT SIMULATOR: The main aim of this experiment is to understand the mechanism involved in an aircraft and helicopter using flying software. Analysis of different mission segments of an aircraft and helicopter will be done.

4. ANALYSIS OF A STEADY LEVEL MANEUVERS AND INSTANTANEOUS MANEUVERS USING 2-D ACCELEROMETER: The main of this experiment is to analyze the data given by accelerometer for Pull-up, Pull- down maneuvers and Steady level turn.

5. FLIGHT MECHANISMS OF AN AIRCRAFT USING AURDINO: The main aim of this experiment is to analyze the actuation mechanisms of an aircraft and helicopter using Aurdnio with the help of mission planner software.

ADVANCED ENGLISH COMMUNICATION SKILLS LAB

B.TECH. III YEAR II SEM.	**L**	**T**	**P**	**C**
Course Code: EN606HS	**0**	**0**	**3**	**2**

Introduction:
A course on *Advanced English Communication Skills (AECS) Lab* is considered essential at the third year level of B.Tech and B.Pharmacy courses. At this stage, the students need to prepare themselves for their career which requires them to listen to, read, speak and write in English both for their professional and interpersonal communication. The main purpose of this course is to prepare the students of Engineering for their placements.

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

- To improve students' fluency in spoken English
- To enable them to listen to English spoken at normal conversational speed
- To help students develop their vocabulary
- To read and comprehend texts in different contexts
- To communicate their ideas relevantly and coherently in writing
- To make students industry-ready
- To help students acquire behavioral skills for their personal and professional life
- To respond appropriately in different socio-cultural and professional contexts

Course Outcomes: Students will be able to:

- Acquire vocabulary and use it contextually
- Listen and speak effectively
- Develop proficiency in academic reading and writing
- Increase possibilities of job prospects
- Communicate confidently in formal and informal contexts

Syllabus
The following course activities will be conducted as part of the Advanced English Communication Skills (AECS) Lab:

1. **Inter-personal Communication and Building Vocabulary** - Starting a Conversation – Responding Appropriately and Relevantly – Using Appropriate Body Language – Role Play in Different Situations - Synonyms and Antonyms, One-word Substitutes, Prefixes and Suffixes, Idioms and Phrases and Collocations.
2. **Reading Comprehension** –General Vs Local Comprehension, Reading for Facts, Guessing Meanings from Context, , Skimming, Scanning, Inferring Meaning.
3. **Writing Skills** – Structure and Presentation of Different Types of Writing – Letter Writing/Resume Writing/ e-correspondence/ Technical Report Writing.
4. **Presentation Skills** – Oral Presentations (individual or group) through JAM Sessions/Seminars/PPTs and Written Presentations through Posters/Projects/Reports/ e-mails/Assignments… etc.,
5. **Group Discussion and Interview Skills** – Dynamics of Group Discussion, Intervention, Summarizing, Modulation of Voice, Body Language, Relevance, Fluency and Organization of Ideas and Rubrics of Evaluation- Concept and Process,

Pre-interview Planning, Opening Strategies, Answering Strategies, Interview through Tele-conference & Video-conference and Mock Interviews.

Minimum Hardware Requirement

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**
- **Eight round tables with five movable chairs for each table.**
- **Audio-visual aids**
- **LCD Projector**
- **Public Address system**
- **Computer with suitable configuration**

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

- **Oxford Advanced Learner's Compass**, 8th Edition
- **DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice.**

REFERENCES:

1. Kumar, Sanjay and Pushp Lata. English for Effective Communication, Oxford University Press, 2015.
2. Konar, Nira. English Language Laboratories – A Comprehensive Manual, PHI Learning Pvt. Ltd., 2011.