PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018

(AUTONOMOUS)

B.E. AERONAUTICAL ENGINEERING

REGULATIONS - 2016

(CHOICE BASED CREDIT SYSTEM)

CURRICULUM

SEMESTER – V

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	AE16501	Gas Dynamics	3	0	0	3
2	PC	AE16502	Aircraft General Engineering and Maintenance Practices	3	0	0	3
3	PC	AE16503	Aircraft Structures II	3	2	0	4
4	PC	AE16504	Aircraft Performance	3	0	0	3
5	PC	AE16505	Rocket Propulsion	3	0	0	3
6	PE	AE1615*	Programme Elective – I*	3	0	0	3
Practical							
7	PC	AE16506	Aircraft Structures II Laboratory	0	0	4	2
8	PC	AE16507	Propulsion laboratory	0	0	4	2
9	EE	EN16501	Career Development Laboratory I	0	0	2	1
			TOTAL	**18**	**2**	**10**	**24**

SEMESTER – VI

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	BA16254	Principles of Management	3	0	0	3
2	PC	AE16601	Computational Fluid Dynamics	3	2	0	4
3	PC	AE16602	Aircraft Stability and Control	3	0	0	3
4	PC	AE16603	Theory of Vibrations	3	0	0	3
5	PE	AE1625*	Programme Elective – II*	3	0	0	3
6	OE	AE169**	Open Elective – I*	3	0	0	3
Practical							
7	PC	AE16604	Aero CAD and CAM Laboratory	0	0	4	2
8	PC	AE16605	Aircraft Engine and Structures Repair Laboratory	0	0	4	2
9	EE	EN16601	Career Development Laboratory II	0	0	2	1
			TOTAL	**18**	**2**	**10**	**24**

PROGRAMME ELECTIVE (PE)

ELECTIVE – I

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	AE16151	Principles of UAV and MAV	3	0	0	3
2	PE	AE16152	Experimental Stress Analysis	3	0	0	3
3	PE	AE16153	Aircraft Communication and Navigation System	3	0	0	3
4	PE	AE16154	Air Traffic control and Planning	3	0	0	3

ELECTIVE – II

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	AE16251	Industrial Aerodynamics	3	0	0	3
2	PE	AE16252	Experimental Aerodynamics	3	0	0	3
3	PE	AE16253	Hypersonic Aerodynamics	3	0	0	3
4	PE	AE16254	Wind Tunnel Techniques	3	0	0	3

OPEN ELECTIVE (OE)

ELECTIVE – I

S.No.	Category	Course Code	Course Title	L	T	P	C
1	OE	AE16901	Aircraft Rules and Regulations	3	0	0	3
2	OE	AE16902	Wind Power Engineering	3	0	0	3
3	OE	AE16903	Aircraft Safety	3	0	0	3
4	OE	AE16904	Active Control Technology	3	0	0	3

SEMESTER V

AE16501 GAS DYNAMICS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- acquire the basic concepts of compressible flow
- understand the behavior of airflow both internal and external in compressible flow regime with particular emphasis on supersonic flows.
- know the theory behind the formation of shocks and expansion fans in Supersonic flows.
- obtain the potential flow in two dimensional compressible flow.
- introduce the methodology of measurements in Supersonic flows.

UNIT I FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW 10

Aerodynamics variables and flow physics - Aerodynamic forces and moments. Definition of Compressible flow. Adiabatic steady state flow equations. Compressibility, continuity, momentum and energy equations for steady one dimensional flow, compressible Bernoulli"s equation, area – mach number – velocity relation, mach Cone, mach angle. Choked flow. Numerical Problems

UNIT II INVISCID, COMPRESSIBLE FLOWS 8

One dimensional flow equations. Quasi-one dimensional flow - one dimensional isentropic flow through variable area duct, critical conditions - characteristic mach number, area-mach number relation - maximum discharge velocity - operating characteristics of nozzles - Isentropic flow through supersonic nozzle.

UNIT III SHOCK AND EXPANSION WAVES 10

Normal shock relations, Prandtl"s relation, Hugoniot equation, Rayleigh Supersonic Pitot tube equation, Oblique shocks, θ-β-M relation, Shock Polar, Reflection of oblique shock - Rayleigh flow, Fanno flow, Expansion waves, Prandtl-Meyer expansion, Attached and detached shocks, Introduction to viscous flow - Introduction to boundary-layers, shock wave boundary-layer interaction.

UNIT IV TWO DIMENSIONAL COMPRESSIBLE FLOW 10

Potential equation for 2-dimensional compressible flow, Linearisation of potential equation, perturbation potential, Linearised Pressure Coefficient, Linearised subsonic flow - Prandtl-Glauert rule, Linearised supersonic flow, Method of characteristics

UNIT V HIGH SPEED FLOWS 7

Critical Mach number, Drag divergence Mach number - Shock Stall, Supercritical Airfoil Sections, Transonic area rule - Swept wing, wave drag - Wind tunnels for transonic - Supersonic and hypersonic flows - shock tube - Gun tunnels - Supersonic flow visualization methods

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- understand and apply the fundamental aspects of compressible flow
- understand and apply the fundamental aspects of compressible flow
- compute the calculations related to shock and expansion waves

- compute the equations for various parameters in two dimensional compressible flow
- elaborate the visualization methods of flow properties

TEXT BOOKS

1. Anderson. J. D, "Modern Compressible Flow", McGraw-Hill and Co., 2002.
2. Rathakrishnan. E,"Gas Dynamics", Prentice Hall of India, 2004.

REFERENCES

1. Shapiro. A. H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronald Press, 1982.
2. Zucrow. M. J. and Anderson, J. D., "Elements of Gas Dynamics", McGraw- Hill and Co., 1989.
3. Oosthuizen. P.H., and Carscallen,W.E., "Compressible Fluid Flow", McGraw- Hill and Co.,1997.

WEB LINKS

1. http://nptel.ac.in/courses/101105059/
2. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-100-aerodynamics-fall-2005/lecture-notes/

Mapping of Course Outcomes with Program Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	3	3	2	-	-	-	3	2	3	3
CO2	3	2	3	3	2	2	2	-	-	-	3	2	3	2
CO3	-	2	1	3	2	2	3	-	-	-	3	2	2	3
CO4	2	2	3	3	2	2	3	-	-	-	3	2	2	2
CO5	2	2	2	2	3	3	2	-	-	-	2	2	3	2

AE16502 **AIRCRAFT GENRAL ENGINEERING AND MAINTENANCE PRACTICES** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- study about the various ground handling procedures of an aircraft
- know about the ground servicing of Aircraft Subsystems.
- learn the safety procedures and precautions requirements
- understand the inspection procedures
- introduce the basic hardware, materials, system processes involved in aircraft

UNIT I AIRCRAFT GROUND HANDLING AND SUPPORT EQUIPMENT 9

Mooring, jacking, leveling and towing operations – Preparation – Equipment – precautions – Engine starting procedures – Piston engine, turboprops and turbojets – Engine fire extinguishing – Ground power unit.

UNIT II GROUND SERVICING OF VARIOUS SUB SYSTEMS 8

Air conditioning and pressurization system and their maintenance – Oxygen and oil systems and their maintenance – Ground units and their maintenance.

UNIT III MAINTENANCE OF SAFETY 8

Shop safety – Electrical Safety – Fire Protection and Fire Safety – Safety Around: Compressed Gases, Hazardous Materials, Machine Tools –Flight Line Safety–Safety Around Airplanes and Helicopters–Environmental cleanliness – Precautions

UNIT IV INSPECTION 10

Process – Purpose – Types – Inspection intervals – Techniques – Checklist – Special inspection –Publications, bulletins, various manuals – FAR Air worthiness directives – Type certificate Data sheets– ATA Specifications

UNIT V AIRCRAFT HARDWARE, MATERIALS, SYSTEM PROCESSES 10

Hand tools – Precision instruments – Special tools and equipments in airplane maintenance shop– Identification terminology – Specification and correct use of various aircraft hardware (i.e. nuts, bolts,rivets, screws etc) American and British systems of specifications – Threads, gears, bearings, etc –Drills, tapes and reamers – Identification of all types of fluid line fittings Materials. Metallic and nonmetallic Plumbing connectors – Cables – Swaging procedures, tests, Advantages of swaging over splicing.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- elaborate the ground handling operations of an aircraft
- carry out ground servicing of critical aircraft systems
- identify the safety requirements in the maintenance bay
- compute the effective inspection required for various parts of an aircraft
- compare the specifications standards of aircraft hardware systems

TEXT BOOKS

1. A and P Mechanics, "Aircraft Hand Book", F A A Himalayan Book House, New Delhi, 1996
2. A and P Mechanics," General Hand Book", F A A Himalayan Bok House, New Delhi, 1996

REFERENCES

1. Kroes Watkins Delp, "Aircraft Maintenance and Repair", McGraw Hill, New York, 1993
2. Brimm D.J. and Bogges H.E., "Aircraft Maintenance", Pitman Publishing corp., New York, 1940.
3. Larry Reithmeir, "Aircraft Repair Manual", Palamar Books, Marquette, 1992.
4. Dale Crane, Aviation Maintenance Technician: Power plants, 2nd edition, Aviation Supplies and Academics Inc,2005
5. Jeppesen Sanderson, Standard Aviation Maintenance Handbook, Jeppesen and Company, 2003

WEB LINKS

1. https://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/amt_handbook/
2. https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/media/pilot_handbook.pdf

Mapping of Course Outcomes with Program Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	3	3	2	-	-	-	-	2	3	3
CO2	2	2	1	2	2	3	3	-	-	-	-	2	3	2
CO3	2	3	2	2	3	2	2	-	-	-	-	2	2	3
CO4	3	3	2	2	3	2	2	-	-	-	-	2	2	2
CO5	2	2	2	2	3	1	2	-	-	-	-	2	3	2

AE16503 **AIRCRAFT STRUCTURES II** **3 2 0 4**

COURSE OBJECTIVES

To enable the students to

- introduce the various structural components of aircrafts
- familiarize with different section of beams subjected to various types of loading.
- know the theoretical and methodological approaches to design aircraft structures.
- provide the knowledge on the importance of structural analysis of aircraft.
- study the behavior of various aircraft structural components under different types of loads.

UNIT I UNSYMMETRICAL BENDING **9+4**

Bending stresses in beams of unsymmetrical sections -K-method-Neutral axis method and Principle axis Method-Bending of symmetric sections with skew loads.

UNIT II SHEAR FLOW IN OPEN SECTIONS **9+7**

Thin walled beams – Concept of shear flow – shear centre – Elastic axis – one axis of symmetry – wall effective and ineffective in bending – unsymmetrical beam sections

UNIT III SHEAR FLOW IN CLOSED SECTIONS **9+7**

Bredt – Batho formula – Single and Multi-cell structures – approximate methods – Shear flow in single, multi-cell structures under torsion – Shear flow in single and multi-cell under bending with walls effective and ineffective.

UNIT IV BUCKLING OF PLATES **9+7**

Rectangular sheets under compression – Local buckling stress of thin walled sections – Crippling stresses by Needha"s and Gerard"s methods – Sheet stiffener panels – Effective width – inter rivet and sheet wrinkling failures.

UNIT V STRESS ANALYSIS IN WING AND FUSELAGE **9+5**

Shear resistant web beams – Tension field web beams (Wagner Beam) – Shear and bending moment distribution for cantilever and semi-cantilever types of beams – loads on aircrafts – lift distribution – V-n diagram – Gust loads.

TOTAL PERIODS 75

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze the response of structures due to unsymmetrical bending.
- identify and analyze structural problems commonly encountered in aircrafts.
- find the shear flow over the section
- determine the effect of a variety of loading and support conditions on the small deflection of beams
- identify various types of structural components and their loading pattern.

TEXT BOOKS

1. Megson T.H.G., "Aircraft Structures for Engineering Students", 4th edition Butterworth Heinemann,
2. Bruhn. E.H. "Analysis and Design of Flight vehicles Structures", Tri – state off set company, USA, (1985).

REFERENCES

1. Peery, D.J., and Azar, J.J., "Aircraft Structures", 2nd edition, McGraw–Hill, N.Y., (1993).
2. Rivello, R.M., "Theory and Analysis of Flight Structures", McGraw-Hill, (1993).
3. Michael Chun-Yung Niu, "Airframe Structural Design: Practical Design Information and Data on Aircraft Structures", 2nd edition, Adaso/Adastra Engineering Center, (2006).
4. Howard D Curtis, "Fundamentals of Aircraft Structural Analysis", WCB-McGraw Hill, (1997)
5. Lakshmi Narasaiah G,"Aircraft Structures", BSP Books Pvt.Ltd-Hyderabad.

WEB LINKS

1. http://nptel.ac.in/courses/105106049/65
2. https://pritamashutosh.wordpress.com

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	3	2	-	3	-	-	-	-	2	3	3
CO2	3	2	2	2	3	-	3	-	-	-	3	2	3	2
CO3	3	2	2	2	2	3	2	-	-	-	2	2	2	3
CO4	3	3	3	2	2	-	2	-	-	-	3	2	2	2
CO5	3	3	3	3	3	2	3	-	-	-	3	2	3	2

AE16504 **AIRCRAFT PERFORMANCE** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- study in detail about fundamentals of flight performance.
- acquire the knowledge of power required and available for steady flight performance.
- impart the students with necessary background for understanding the physical behavior of flight during maneuvers.
- study and understand the various special performance of an aircraft.
- familiarize the students with performance of various pitch propeller.

UNIT I LIFT AND DRAG ON FLIGHT PERFORMANCE **12**

Streamlined and bluff bodies, aerofoil classification - Aerofoil characteristics, Pressure distribution around aerofoil. Types of drag, Effects of Reynold"s number on skin friction and pressure drag, Drag reduction of airplanes. Induced drag, Chord wise and span wise pressure distribution - Aspect ratio, Camber and plan form characteristics - drag polar.

UNIT II STEADY FLIGHT **8**

Steady level flight - Thrust/power - available and required with altitude Estimation of maximum level flight speed - conditions for minimum drag and minimum power required

UNIT III GLIDING, CLIMBING AND TURING PERFORMANCE **12**

Maximum range - Minimum rate of skin a glide, Shallow angle of climb, Rate of climb, time to climb and ceilings, Glide hodograph. Bank angle and load factor, Limitations on turn - Pull up and push over - the v-n diagram.

UNIT IV SPECIAL PERFORMANCE **6**

Range and endurance of jet and propeller type of airplanes, estimation of take-off and landing distance. High lift devices, Use of thrust augmentation and reverse thrust.

UNIT V PROPELLERS **7**

Froude momentum and blade element theories, Propeller coefficients, Use of propeller charts, performance of fixed and variable pitch propeller.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze the aerodynamics forces and performance of an aircraft.
- evaluate the power required and available for steady flight performance.
- compute the various load factor performance.
- compare the various performance of an aircraft.
- identify the various performance of pitch propeller and its charts.

TEXT BOOKS

1. John D. Anderson,Jr Aircraft performance and design
2. Houghton,E.L,Carruthers.N.B, "Aerodynamics for engineering students", Edward Arnold Publishers, 1988.

REFERENCES

1. L.J.Clancy, Aerodynamics, Pitman, 1986.
2. Kuethe, A.M., and Chow, C.Y., Foundations of Aerodynamics, John Wiley and Sons, 1982
3. J.J. Bertin, Aerodynamics for engineers, Prentice-hall, 1988.
4. Schlichting, E., Aerodynamics of the Airplane, McGraw-Hill, 1979.
5. A.C.Kermode., "Mechanics of Flight"

WEB LINKS

1. http://nptel.ac.in/downloads/101104007/
2. http://nptel.ac.in/courses/101106041/

Mapping of Course Outcomes with Program Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	3	2	-	-	-	-	-	2	2	3	3
CO2	2	2	3	2	2	2	-	-	-	-	2	2	3	2
CO3	2	2	3	3	2	3	-	-	-	-	1	2	2	3
CO4	2	3	2	2	3	2	-	-	-	-	3	2	2	2
CO5	1	2	2	2	3	2	-	-	-	-	3	2	3	2

AE16505 **ROCKET PROPULSION** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- study in detail about fundamentals of chemical rockets, rocket propulsion and advanced propulsion techniques
- acquire an overview of various rocket technologies and applications.
- impart students with a sound fundamental in gas dynamics, thermo chemistry, heat transfer, and vehicle dynamics as related to rocket motor/vehicle analysis.
- familiarize students with a sound fundamental in analyzing /designing various rocket propulsion systems such as liquid propellant rocket motors, solid propellant rocket motors.
- understand about the multi-stage launch vehicles, arc jets, solid core nuclear thermal rocket motors, and ion thrusters.

UNIT I DEFINITIONS AND FUNDAMENTALS **9**

Operating principle of chemical rockets. Definitions: Rocket thrust, Exhaust velocity, Specific Impulse, Vehicle acceleration - Effective exhaust velocity, Characteristic velocity, Mass ratio, Propellant mass fraction, Burning time - Total impulse - Thrust coefficient, Isentropic flow throw nozzles, Rocket nozzle classifications. Under and over expanded nozzles - Optimum expansion - Numerical Problems.

UNIT II IGNITION SYSTEMS IN ROCKETS **9**

Types of solid propellant rocket igniters – Pyrotechnic igniters and pyrogen igniters. Igniter Design spreading, Considerations: Igniter mass and chamber volume, Ignition Chain: Ignition delay, mode of heat transfer, flame Deflagration and Detonation. Hypergolic ignition. Ignition systems in liquid rockets.

UNIT III SOLID PROPELLANT ROCKETS **9**

Selection criteria of solid propellants – Important hardware components of solid rockets. Propellant grain design considerations. Burn rate. Internal ballistics - Pressure-time curve. Starting transient, erosive burning, Rocket performance considerations – Staging of rockets. Thrust vector control. Thrust termination techniques, Numerical problems.

UNIT IV LIQUID PROPELLANT ROCKETS **9**

Liquid propellant rocket engine fundamentals. Liquid propellants. Propellant feed systems. Selection of liquid propellants. Valves and pipe lines. Thrust chambers. Injectors, combustion chamber and nozzle, Combustion Instability. Secondary injection thrust vector control in liquid rockets – Cooling in liquid rockets. Numerical Problems. Introduction to hybrid rockets – Relative advantages of liquid rockets over solid rockets. Types of Rocket tests. Rocket exhaust plumes.

UNIT V ADVANCED PROPULSION TECHNIQUES **9**

Cryogenic rockets - Satellite thrusters - Electric rockets - Ion propulsion techniques - Nuclear rockets – Types, Sail, Anti-matter propulsion - Preliminary Concepts in nozzle less propulsion.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze the fluid flow in a rocket nozzle

- compute the preliminary heat transfer calculations in a rocket nozzle
- design various rocket motor systems to satisfy a wide range of applications
- elaborate about the solid-core nuclear thermal rockets, arc jets, and ion thrusters
- analyze a rocket engine system to determine its specific impulse and performance.

TEXT BOOKS

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley and Sons Inc., New York, 7th edition.
2. Kou.K.K and Summerfield.M., Fundamental Aspects of Solid Propellant Rockets, Progress in and Aeronautics, AIAA, Vol.90, 1982.

REFERENCES

1. Barrere.M, "Rocket Propulsion", Elsevier Publishing Company, New York, 1960.
2. Hill, P.G. and Peterson, C.R. "Mechanics and Thermodynamics of Propulsion" 2nd Edition Pearson Education, 1999.
3. Gordon Oates, "Aero thermodynamics of Gas Turbine and Rocket Propulsion", AIAA Education Series, York, 1989.
4. J.W.Cornelisse, H.F.R.Schoyer, K.F.Wakker, "Rocket Propulsion and Spaceflight Dynamics," Pitman, London. (1979)

WEB LINKS

1. http://nptel.ac.in/courses/112106073/
2. http://nptel.ac.in/courses/101104019/
3. http://www.nptelvideos.in/2012/12/rocket-propulsion.html
4. http://nptel.ac.in/syllabus/112106073/

Mapping of Course Outcomes with Program Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	2	2	-	-	-	3	2	3	3
CO2	2	3	3	2	3	2	2	-	-	-	3	2	3	2
CO3	-	1	3	2	3	2	2	-	-	-	2	-	2	3
CO4	-	3	2	3	2	-	3	-	-	-	3	2	2	2
CO5	-	2	3	3	3	3	-	-	-	3	2	2	3	2

COURSE OBJECTIVES

To enable the students to

- understand the behavior of structural components with different loading conditions.
- know the shear center location of open and closed section
- find the fringe value of the material
- gain knowledge of tensioned specimen

LIST OF EXPERIMENTS

1. Determination of principle plane of unsymmetrical section
2. Determination of Shear centre location for Z sections
3. Determination of Shear centre location for open channel sections
4. Determination of Shear centre location for angle sections
5. Calibration of Photo- elastic materials using plane polariscope
6. Calibration of Photo- elastic materials using circular disc under compression
7. Calibration of Photo- elastic material using beam subjected to pure tension
8. Determination of forces in wire of hinged bar experiment
9. Wagner beam – Tension field beam with gauge mounting practices
10. Determine the acceleration and velocity by vibration test
11. Determination of elastic constant for composite tensile specimen
12. Fabrication of composite laminate

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- evaluate the numerical analysis of structural components.
- estimate the shear center of various section
- identify the fringe value of the materials
- fabricate the different composite laminates

Mapping of Course Outcomes with Program Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	3	-	-	-	2	-	2	-	3	3
CO2	3	2	1	-	2	-	3	-	3	-	3	-	3	2
CO3	3	2	2	-	3	-	2	-	2	-	2	-	2	3
CO4	3	2	2	-	2	-	2	-	3	-	2	-	2	2

AE16507 **PROPULSION LABORATORY** **0 0 4 2**

COURSE OBJECTIVES

To enable the students to

- understand the basic concepts in aerospace propulsion.
- gain the knowledge about piston engine and jet engine components.
- familiarize student with a calibration test.
- learn the testing of different jets and velocity profile.

LIST OF EXPERIMENTS

1. Velocity profiles of free jets.
2. Velocity profiles of wall jets.
3. Free convective heat transfer over a cylinder.
4. Forced convective heat transfer over a cylinder.
5. Determination of Thermal Resistance of a Composite wall.
6. Calibration of Fuel Test rig
7. Study of an aircraft piston engine.
8. Study of an aircraft jet engine compressor.
9. Study of jet engine combustion chamber.
10. Study of jet engine turbine.
11. Determination of calorific value of Aviation Fuel

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze the performance of various aircraft piston and gas turbine engines components.
- compute the flow behavior of jets
- identify various testing methods of variable area ducts, jet engine components
- estimate the calorific value of various types of fuels.

Mapping of Course Outcomes with Program Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

	Programme Outcomes (POs)												PSOs	
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	-	-	3	2	-	3	-	3	2	3	3
CO2	2	3	3	3	2	2	2	-	3	-	2	2	3	2
CO3	3	2	2	3	3	3	2	-	2	-	3	-	2	3
CO4	2	2	-	-	2	3	2	-	3	-	3	-	2	2

EN16501 **CAREER DEVELOPMENT LABORATORY I** **0 0 2 1**

COURSE OBJECTIVES

To enable the students to

- understand their capabilities and enhance their grooming and showcasing his/her capabilities to a prospective employer
- provide opportunity for the students to become acquainted with corporate opportunities relevant to their academic learning
- articulate their thoughts on a given topic – in English and also to make decent write ups in English on any given topic
- practice and score well in Aptitude tests conducted by corporate / prospective employers
- prepare for any group discussion evaluation or presenting their credentials during a face –to- face interview leading to selection and employment

UNIT I BASICS - SELF ANALYSIS **10**

Introduction - Self Explorations: Who Am I, Personal Attributes, Self Confidence and Self Esteem - Communication Skills : Introduction to communication, Flow of communication, Listening, Barriers of communications, How to overcome the barriers of communications - Leadership Qualities : Skills for a good Leader, Leadership styles, SWOT Analysis, - Time Management: Time is a resource, Identify Time wasters, Time Management Styles, Techniques for better time management - Group Dynamics/ Team Building : Importance of group in organizations, Team Building, Interaction with the team, How to build the good team

UNIT II PERSONALITY DEVELOPMENT **5**

Motivation : Introduction, Relevance and types of motivation, Analysis of motivation - Attitude : Factors, Influencing Attitude, Challenges and lessons from attitude - Creativity : Out of box thinking, Lateral thinking - Goal Setting : Wish list ; Blue print for success; Short, long, life time goals

UNIT III QUANTITATIVE APTITUDE **5**

Number System - LCM and HCF - Square root and Cube root – Percentage - Time speed and Distance

UNIT IV QUANTITATIVE APTITUDE **5**

Trains - Boats and Streams – Average – Ages - Area

UNIT V LOGICAL AND VERBAL REASONING **5**

Series Completion : Number Series, Letter series, Symbol Series - Blood Relation - Coding and decoding – Logical Sequence – Analogy - Character Puzzles – Classification - Data sufficiency

TOTAL PERIODS 30

COURSE OUTCOMES

At the end of this course, students will be able to

- demonstrate aptitude and reasoning skills
- enhance verbal and written ability
- improve his/her grooming and presentation skills
- interact effectively on any recent event / happenings / current affairs.
- be a knowledgeable person on the various evaluation processes leading to employment and face the same with confidence

TEXT BOOKS

1. Agarwal, R.S." a modern approach to Verbal and Non Verbal Reasoning", S.Chand and Co Ltd, New Delhi.
2. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hill.

REFERENCES

1. Word Power Made Easy By Norman Lewis ,Wr.Goyal Publications
2. Johnson, D.W. Reaching out - Interpersonal Effectiveness and self actualization. Boston: Allyn and Bacon.
3. Agarwal, R.S. " Objective General English", S.Chand and Co
4. Infosys Campus Connect Program – students" guide for soft skills.

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	3	1	-	-	-	-	-	-	3	2
CO2	-	2	3	-	2	-	2	-	-	-	-	-	3	2
CO3	3	2	2	2	-	-	1	-	-	-	-	-	2	3
CO4	3	2	2	-	-	1	-	-	-	-	2	-	2	3
CO5	2	3	3	2	1	3	3	1	-	1	2	-	2	3

SEMESTER VI

BA16254 PRINCIPLES OF MANAGEMENT 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand history and development of management thought.
- know the planning activities in management.
- understand organizing, dimensions of organization structure, and choosing the right structural form.
- know how to manage human resources.
- understand various methods and techniques of control

UNIT I INTRODUCTION TO MANAGEMENT 9

Management: Meaning, Scope, Managerial Roles. Management: Science, Art or Profession; Universality of Management, Ancient roots of management theory; Classical schools of management thought; Behavioral School, Quantitative School; Systems Approach, Contingency Approach; Contemporary Management thinkers and their contribution.

UNIT II PLANNING 9

Characteristics of planning, Planning Process; Types of plans; Decision making, Decision making tools, Group decision making, Forecasting and MBO.

UNIT III ORGANIZING 9

Organizational structure and design; types of organizational structures; authority, delegation, decentralization and reengineering; Organization Size, Technology, Environment, Power-control; choosing the right structural form

UNIT IV MANAGING HUMAN RESOURCES 9

Human resource planning, Recruitment, selection, training and development, performance appraisal, managing change, compensation and employee welfare, leadership theory, motivation theory, communication

UNIT V CONTROLLING 9

Nature of organizational control; control process; Methods and techniques of control; Designing control systems.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able

- To demonstrate history and development of management thought.
- To exhibit the planning activities in management.
- To know organizing, dimensions of organization structure, and choosing the right structural form.
- To gain knowledge how to manage human resources.
- To develop various methods and techniques of control.

TEXT BOOKS

1. Management a Global and Entrepreneurial Perspective, Heinz Weihrich, Mark V. Cannice, Tata McGraw-Hill Education, 2010.
2. Management, James A.F. Stoner and R. Edward Freeman, Prentice-Hall of India Private Limited, New Delhi, 5/e, 2010.

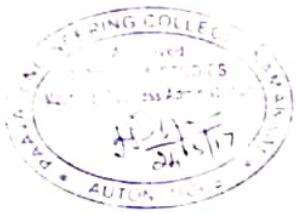
REFERENCES

1. Management, John R. Schermerhorn, Jr., Daniel G. Bachrach, Wiley India, 13/e, 2015.
2. Essentials of Management, Joseph L Massie, Prentice-Hall India, New York, 4/e, 2013.
3. Management, S.A.Sherlekar, Himalaya Publications, Mumbai, 1/e, 2012.
4. Principles of Management, L.M. Prasad, Sultan Chand and Sons, New Delhi, 9/e, 2015.

WEB LINKS

1. https://www.slideshare.net/ersmbalu/principles-of-management-lecture-notes
2. mbaexamnotes.com/principles-of-management.html
3. https://www.cliffsnotes.com/study-guides/principles-of-management

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	3	-	-	3	2	2	3	3	2	3	-	-
CO2	-	-	2	-	-	3	3	3	2	2	3	2	-	-
CO3	-	-	3	-	-	2	3	2	3	3	2	2	-	-
CO4	-	-	3	-	-	3	2	3	3	3	2	3	-	-
CO5	-	-	2	-	-	2	2	3	2	2	3	3	-	-



AE16601 **COMPUTATIONAL FLUID DYNAMICS** **3 2 0 4**

COURSE OBJECTIVES

To enable the students to

- gain the basic flow equations, characteristics of mathematical model for a given flow.
- know the importance and significance of grid generation methods.
- understand the concepts of discretization, upwind differencing and implicit, explicit solutions
- familiarize with finite element techniques in computational fluid dynamics.
- learn with aerospace application in computational fluid analysis.

UNIT I FUNDAMENTAL CONCEPTS **9+6**

Introduction - Basic Equations of Fluid Dynamics - Review of Source sink Panel methods- lifting flows over arbitrary bodies. Mathematical properties of Fluid Dynamics Equations - Elliptic, Parabolic and Hyperbolic equations - Well posed problems - discretization of partial Differential Equations. Introduction to Finite Difference method

UNIT II GRID GENERATION **9+6**

Structured grids. Types and transformations. Generation of structured grids. Unstructured grids. Delany triangulation.

UNIT III DISCRETIZATION **9+6**

Boundary layer Equations and methods of solution -Implicit time dependent methods for inviscid and viscous compressible flows - Concept of numerical dissipation --Stability properties of explicit and implicit methods - Conservative upwind discretization for Hyperbolic systems - Further advantages of upwind differencing.

UNIT IV FINITE VOLUME TECHNIQUES **9+6**

Finite Volume Techniques - Cell Centered Formulation - Lax - Vendoroff Time Stepping - Runge - Kutta Time - Stepping - Multi - stage Time Stepping - Accuracy -. Cell Vertex Formulation - Multistage Time Stepping – FDM like Finite Volume Techniques - Central and Up-wind Type Discretizations - Treatment of Derivatives. Flux splitting schemes. Pressure correction solvers – SIMPLE, PISO. Vorticity transport formulation. Implicit/semi-implicit schemes

UNIT V APPLICATION OF CFD **9+6**

Numerical solution of flow over a cylinder using 2-D panel methods using both vertex and source panel methods for lifting and non lifting cases respectively. Numerical solution of 1-D conduction- convection energy equation using time dependent methods using both implicit and explicit schemes – application of time split method for the above equation and comparison of the results

TOTAL PERIODS 75

COURSE OUTCOMES

At the end of the course, the students will be able to

- elaborate the flow phenomena in a flow field with correspondence with elliptic, parabolic and hyperbolic equations.
- identify the steps involved in source and panel methods.
- discretize a flow model for analysis.
- compute the values using weighted, variational and Galerkin method of finite volume technique.

- analyze the numerical methods of aerospace application in computational

TEXT BOOKS

1. John F. Wendt (Editor), "Computational Fluid Dynamics - An Introduction", Springer – Verlag, Berlin, 1992
2. Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics", Vols. I and II, Springer - Verlag, Berlin,1988

REFERENCES

1. Charles Hirsch, "Numerical Computation of Internal and External Flows", Vols. I and II. John Wiley and Sons, New York, 1988.
2. Anderson, Jr.D., "Fundamentals of Aerodynamics", McGraw-Hill, 2000.
3. Klaus A Hoffmann and Steve T. Chiang. "Computational Fluid Dynamics for Engineers", Vols. I and II
4. Engineering Education System, P.O. Box 20078, W. Wichita, K.S., 67208 - 1078 USA, 1993.
5. Versteeg.H and Malalasekera W "An Introduction to Computational Fluid Dynamics: The Finite Volume Method" Prentice Hall,2008

WEB LINKS

1. http://nptel.ac.in/courses/112107080/
2. http://nptel.ac.in/courses/103106073/
3. http://nptel.ac.in/courses/112105045/

Mapping of Course Outcomes with Program Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	3	3	3	-	-	-	-	3	1	3	2
CO2	3	2	2	2	-	1	-	-	-	-	2	2	3	2
CO3	2	3	3	-	-	1	-	-	-	-	3	2	2	2
CO4	2	1	2	-	-	2	-	-	-	-	2	2	3	2
CO5	3	2	3	-	2	2	-	-	-	-	2	1	3	2

AE16602 AIRCRAFT STABILITY AND CONTROL 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- acquire the necessary background for understanding the stability and control of an aircraft.
- study and understand the various longitudinal stability characters.
- familiarize the applications of various aircraft components towards the lateral stability and control.
- impart the knowledge of directional stability.
- understand the basic concepts of special maneuvers like spin, dutch roll, autorotation and spiral.

UNIT I INTRODUCTION **4**

Degrees of freedom of a system - Static and dynamic stability, Need for stability in an airplane, purpose of controls, Inherently and marginally stable airplanes.

UNIT II STATIC LONGITUDINAL STABILITY: **14**

Stick fixed: Basic equations of equilibrium, Stability criterion - Wing and tail moments, Effect of fuselage and nacelles, Effect of c.g. location, Power effects, Stabiliser setting and c.g. location, Elevator effects, stick fixed neutral point. Stick free: Hinge moment coefficients, Stick free neutral point symmetric maneuvers, stick force gradients and stick force per cg. Aerodynamic balancing of control surfaces.

UNIT III STATIC LATERAL STABILITY **6**

Dihedral effect - coupling between rolling moment and yawing moment, Adverse yaw, Aileron power, Aileron reversal

UNIT IV STATIC DIRECTIONAL STABILITY **6**

Weather cocking effect, rudder requirements. One engine inoperative conditions, rudder lock.

UNIT V DYNAMIC STABILITY **15**

Equation of motion, Stability derivatives - Routh"s discriminant, solving the stability quadratic - Phugoid motion, factors affecting the period and damping, Dutch roll and spiral instability Auto rotation and spin, Two control airplane

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- elaborate about the degrees of freedom and stability of an aircraft.
- analyze the stability of an aircraft under various operating conditions.
- identify the concepts behind the lateral stability.
- compute the problems in control systems of an aircraft.
- elaborate the static and dynamic response of aircraft for both voluntary and involuntary changes in flight conditions.

TEXT BOOKS

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley and Son: Inc, New York, 1988.

REFERENCES

1. Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, New York, 1982

2. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co.,1998.
3. Clancy, L.J., "Aerodynamics", Pitman, 1986
4. Bandu N. Pamadi., "Performance, Stability, Dynamics, and Control

WEB LINKS

1. http://nptel.ac.in/courses/101106043/
2. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-333-aircraft-stability-and-control-fall 2004/lecture-notes/

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	3	3	3	-	-	-	-	3	1	3	2
CO2	3	2	2	2	-	1	-	-	-	-	2	2	3	2
CO3	2	3	3	-	-	1	-	-	-	-	3	2	2	2
CO4	2	1	2	-	-	2	-	-	-	-	2	2	3	2
CO5	3	2	3	-	2	2	-	-	-	-	2	1	3	2

AE16603 **THEORY OF VIBRATIONS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- know about the Basic terminologies
- understand the vibration measuring instrument
- study the vibration absorber
- learn the vibration of elastic bodies
- gain the knowledge of different methods of finding natural frequency

UNIT I BASIC NOTIONS **6**

Simple harmonic motion-addition-Terminologies - Newton's Law - D'Alembert's principle-Energy Methods for free vibration

UNIT II SINGLE DEGREE OF FREEDOM SYSTEMS **9**

Free vibrations – Damped vibrations – Forced Vibrations, with and without damping –support excitation – Vibration measuring instruments

UNIT III MULTI DEGREES OF FREEDOM SYSTEMS **12**

Two degrees of freedom systems – Static and Dynamic couplings vibration absorber-Principal co- ordinates, and Principal modes and orthogonal condition – Eigen value problems. Hamilton"s principle- Lagrangean equation application.

UNIT IV CONTINUOUS SYSTEMS **9**

Vibration of elastic bodies-Vibration of strings- Longitudinal, Lateral and Torsional vibrations.

UNIT V APPROXIMATE METHODS AND ELMENTS OF AEROELASTICITY **9**

Rayleigh"s method- Holzer Method- Vibration due to coupling of bending and torsion – aeroelastic problems – collars triangle wing divergence – aileron control reversal – flutter – buffeting. – elements of servo elasticity

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of the course, the students will be able to

- perform basic concept of vibration
- describe the working principles of Dampers and vibration measuring instruments
- identify the different parameters of a vibrating system
- compute the vibration on elastic bodies
- estimate the natural frequency for different kinds of methods

TEXT BOOKS

1. Timoshenko S., "Vibration Problems in Engineering"– John Wiley and Sons, New
2. Tse. F.S., Morse, I.F., Hinkle, R.T., "Mechanical Vibrations", – Prentice Hall, New York, 1984
3. Tongue. B. H., "Principles of Vibration", Oxford University Press, 2000.

REFERENCES

1. T. Gowda, D.V.Girish, T.Jagadeesha, "Mechanical vibrations", McGraw Hill Edu, 2012.
2. Singiresu S. Rao "Mechanical Vibrations" 5th edition, Prentice Hall, 2010
3. Rao S S "Mechanical Vibrations" Prentice Hall,Fifth edition, 2010.

WEB LINKS

1. http://nptel.ac.in/courses/112103111/
2. http://nptel.ac.in/courses/112103112/

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes (POs)**												**PSOs**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	3	2	3	-	2	-	-	-	2	2	3	3
CO2	3	3	2	3	2	-	2	-	-	-	3	2	3	2
CO3	2	2	3	2	3	-	3	-	-	-	3	2	2	3
CO4	3	2	3	2	3	-	3	-	-	-	3	2	2	2
CO5	3	1	3	2	3	-	3	-	-	-	2	2	3	2

AE16604 **AERO CAD AND CAM LABORATORY** **0 0 4 2**

COURSE OBJECTIVES

To enable the students to

- develop skill to use software to create 2D and 3D models.
- train the students about the different types of operation by using CNC.
- teach the student to design the layout of control system and engine components
- design the different welding joints by using software.

LIST OF EXPERIMENTS

1. Design of piston engine components (radial Engine)
2. Design of Jet Engine components
3. Design of welded and riveted joints
4. Computer aided modeling of typical aircraft wing.
5. Computer aided modeling of typical fuselage structure.
6. Computer aided modeling of landing gear
7. Three view diagram of a typical aircraft
8. Facing and Turning (Taper, Step) operations.
9. Drilling operations
10. Layout of control systems

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- operate the CAM
- prepare the layout of aircraft component
- develop the model aircraft component using software
- perform structural analysis using software packages.

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programme Outcomes (POs)												PSOs	
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	2	-	3	-	-	-	-	-	-	2	3	3
CO2	1	2	2	-	1	-	-	-	-	-	-	2	3	2
CO3	1	2	2	-	3	-	-	-	-	-	-	2	2	3
CO4	1	2	2	1	3	-	-	-	-	-	-	2	2	2

AE16605 AIRCRAFT ENGINE AND STRUCTURES REPAIR LABORATORY 0 0 4 2

COURSE OBJECTIVES

To enable the students to

- give training on riveting, patchwork, welding and carpentry
- learn the dismantling procedure for a piston engine.
- practice the different patch repairs and wood gluing joint
- know the composite materials with different resins.

LIST OF EXPERIMENTS

1. Dismantling of a piston engine
2. Engine (Piston Engine) - cleaning, visual inspection, NDT checks.
3. Piston Engine Components - dimensional checks.
4. Piston – Engine reassembly.
5. Engine starting procedures.
6. Aircraft wood gluing-single and double scarf joints
7. Welded single and double V-joints.
8. Fabrication of Composite Materials
9. Riveted Patch repairs
10. Tube bending and flaring
11. Study on MIG, TIG and PLASMA welding of aircraft components

TOTAL PERIODS 60

COURSE OUTCOMES

At the end of this course, students will be able to

- identify the engine components
- obtain the repair work of airframe
- analyze riveted joints
- inspect the piston engine defects.

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
	Programme Outcomes (POs)												PSOs	
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO2	2	2	3	3	1	2	-	-	-	-	3	2	3	2
CO3	1	2	3	1	1	-	-	-	-	-	2	2	2	3
CO4	3	2	2	1	3	2	-	-	-	-	3	2	2	2

EN16601 **CAREER DEVELOPMENT LABORATORY II** **0 0 2 1**

COURSE OBJECTIVES

To enable the students to

- understand their capabilities and enhance their grooming and showcasing his/her capabilities to a prospective employer
- provide opportunity for the students to become acquainted with corporate opportunities relevant to their academic learning
- articulate their thoughts on a given topic – in English and also to make decent write ups in English on any given topic
- practice and score well in Aptitude tests conducted by corporate / prospective employers
- prepare for any group discussion evaluation or presenting their credentials during a face –to- face interview leading to selection and employment

UNIT I CORPORATE READINESS **10**

Business communication – Email, Paragraph, Letter Writing Skills - Public speaking skills : Rules of Public speaking skills; Extempore, JAM - Inter and intra personal skills : Introduction ; Need for Inter and Intra personal skills in organizations - Stress management : Causes of stress and its impact, How to manage and distress, Circle of control, stress busters - Emotional Intelligence : What is emotional Intelligence, Why Emotional Intelligence Matters, Managing Emotions

UNIT II INTERVIEW SKILLS **5**

Interview Basics : General Selection process, Grooming, Dress code, Supporting Documents to carry - Resume Building : Impact of Powerful CV, Do"s and don"ts in CV - Group Discussion : Introduction to GD, Important of Listening and Speaking skills, Do"s and Don"t in GD - Face to face interview / Hire me: Rules for face to face interview, body language, Self Introduction - Psychometric Assessment : Importance of Psychometric assessment, Why psychometric assessment

UNIT III QUANTITATIVE APTITUDE **5**

Simplification - Time and work - Pipes and cisterns - Ratio and Proportion - Partnership

UNIT IV QUANTITATIVE APTITUDE **5**

Simple interest and Compound interest - Profit and loss - Permutation and combination Probability - Calendar

UNIT V LOGICAL AND VERBAL REASONING **5**

Seating arrangement – Direction - Arithmetic reasoning – Syllogisms - Making Judgments - Statements and conclusions - Matching definition - Cause and effect

TOTAL PERIODS 30

COURSE OUTCOMES

At the end of this course, students will be able to

- demonstrate aptitude and reasoning skills
- enhance verbal and written ability
- improve his/her grooming and presentation skills
- interact effectively on any recent event / happenings / current affairs.
- be a knowledgeable person on the various evaluation processes leading to employment and face the same with Confidence

TEXT BOOKS

1. Agarwal, R.S. "A modern approach to Verbal and Non Verbal reasoning", S.Chand and Co Ltd, new delhi.
2. Abhijit Guha, "Quantitative Aptitude", Tata-Mcgraw Hill.

REFERENCES

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3. Agarwal, R.S. " Objective General English", S.ChandandCo
4. Infosys Campus Connect Program – students"s guide for soft skills.
5. Mitra ,barun.k, " Personalaity Development and Softskills " , Oxford University.

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CO3	3	2	2	2	-	-	1	-	-	-	-	-	2	3
CO4	3	2	2	-	-	1	-	-	-	-	2	-	2	3
CO5	2	3	3	2	1	3	3	1	-	1	2	-	2	3

PROGRAMME ELECTIVE I

AE16151 PRINCIPLES OF UAV AND MAV 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- know the importance of unmanned aerial vehicle
- understand the application of UAV system
- learn the basic hardware of UAV
- interpret the basic concepts of controlling of forces and moments on models during the payload
- perform the flight analysis

UNIT I INTRODUCTION TO UAV AND MAV 9

Historical Background of UAVs and MAVs -classifications based on range and Endurance –basic terminology- models and prototypes - Preliminary, Conceptual and Detailed design stages.

UNIT II DESIGN OF UAV SYSTEM 9

Fixed wing -Rotor -VTOL-STOL- Blimb wing Airframe - flapping wing - dynamics –modeling fuselage structures - Airfoil selection - Propeller selection - Empennage design -Flight control surfaces specifications - Airframe maintenance.

UNIT III HARDWARE SUPPORT 9

Autopilot sensors, servos, accelerometer, gyros, actuators-, power supply processor, integration, installation, Configuration.

UNIT IV PAYLOADS AND CONTROLS 9

Payloads, Telemetry, tracking - Aerial photography, controls, PID feedback, radio control frequency range, modems, Memory system, simulation, ground test-analysis, trouble shooting.

UNIT V PATH PLANNING 9

Path planning ,Trajectory generations, Obstacles avoidance ,Endurance ,Way points navigation ground control Software, Flight Endurance and Range ,analysis of existing UAVs and MAVs.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze the classification of UAV
- identify and analyze UAV system and structures
- identify the theory behind the hardware
- determine the effect of payload
- identify various types of planning and trajectory

TEXT BOOKS

1. Fahlstrom, P. and Gleason, T. 2012. Introduction to UAV Systems. 4th edition. United Kingdom. John Wiley and Sons Ltd.
2. Wolf, P., DeWitt, B., and Wilkinson, B. 2014. Elements of Photogrammetry with Applications in GIS, 4th Edition. McGraw-Hill.

3. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010

REFERENCES

1. Dr. Armand J. Chaput,"Design of Unmanned Air Vehicle Systems" Lockheed Martin Aeronautics Company, 2001
2. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998
3. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
4. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

WEB LINKS

1. http://nptel.ac.in/courses/101106035/
2. https://www.uavsystemsinternational.com/

Mapping of Course Outcomes with Program Outcomes
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)												PSOs	
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CO3	2	2	3	3	2	3	-	-	3	-	2	2	2	3
CO4	-	1	3	2	2	2	-	-	3	-	3	2	2	2
CO5	-	3	-	3	2	2	-	-	3	-	3	2	3	2

AE16152 EXPERIMENTAL STRESS ANALYSIS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the relation between the mechanics theory and experimental stress analysis.
- bring consciousness on experimental method of finding the response of the structure to different types of load.
- learn the fundamental concepts and newly experimental techniques.
- use the experimental techniques on the practical problems
- know the fundamental aspects of different non destructive testing techniques

UNIT I EXTENSOMETERS AND DISPLACEMENT SENSORS 8

Principles of measurements - Accuracy, Sensitivity and range of measurements, Mechanical, Optical, Acoustical and Electrical extensometers and their uses - Advantages and disadvantages, Capacitance gauges, Laser displacement sensors

UNIT II ELECTRICAL RESISTANCE STRAIN GAUGES 12

Principle of operation and requirements, Types and their uses, Materials for strain gauges, Calibration and temperature compensation, cross sensitivity - Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators, Rosette analysis, stress gauges, load cells

UNIT III PHOTOELASTICITY 11

Two dimensional photo elasticity, Photo elastic materials, Concept of light - photoelastic effects, stress optic law, Transmission photoelasticity, plane and circular polariscope, Interpretation of fringe pattern, Calibration of photoelastic materials, Compensation and separation techniques, Introduction to three dimensional photo elasticity.

UNIT IV BRITTLE COATING AND MOIRE TECHNIQUES 7

Relation between stresses in coating and specimen - use of failure theories in brittle coating, Moire method of strain analysis.

UNIT V NON – DESTRUCTIVE TESTING 7

Fundamentals of NDT - Acoustic Emission Technique, Radiography, Thermography, Ultrasonic, Eddy Current testing, Fluorescent Penetrant Testing,

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- elaborate the various experimental techniques which is used to determine the structural properties
- execute the physics of strain measurement techniques
- analyse the principles and techniques of photoelastic measurement to perform a structural analysis
- perform the Moire method of analysis
- different method of NDT and its applications.

TEXT BOOKS

1. Dr. Sadhu Singh, "Experimental stress analysis", Khanna Publications.(1989).
2. Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", College House Enterprises, New York, 2005

REFERENCES

1. Srinath, L.S., Raghava, M.R., Lingaiah,K., Garagesha,G. Pant B. and Ramachandra,K., "Experimental Stress Analysis", Tata McGraw-Hill, NewDelhi,(1984).
2. Ramesh K, "Digital Photoelasticity, Advanced Techniques and Applications", Springer,(2000).
3. Jindal U C, "Experimental Stress Analysis", 1st edition, Pearson, (2012).
4. Allesandro Freddi, Giorgio Olmi, Luca Cristofolini, "Experimental Stress Analysis for Materials and Structures", Springer, (2015).

WEB LINKS

1. http://nptel.ac.in/courses/112106068/
2. https://swayam.gov.in/course/1309-experimental-stress-analysis-an-overview

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	-	2	-	-	-	2	-	2	2	3	3
CO2	3	2	3	3	3	3	-	-	-	-	3	-	3	2
CO3	2	2	3	3	2	3	-	-	3	-	2	2	2	3
CO4	-	1	3	2	2	2	-	-	3	-	3	2	2	2
CO5	-	3	-	3	2	2	-	-	3	-	3	2	3	2

AE16153 AIRCRAFT COMMUNICATION AND NAVIGATION SYSTEM 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the needs for avionics for both Civil and military aircraft.
- introduce various digital electronic principles and working operations of digital circuit.
- integrate the digital electronics with cockpit equipments
- understand the various principles in flight disk and cockpit panels.
- study the communication and navigation equipment

UNIT I COMMUNICATION SYSTEM AND MODULATIONS 9

Communication systems: signals, analogue, digital and coded forms, time and frequency representation, signal spectra, types of distortion Information : Nature and measure, influence of bandwidth and signal/noise ratio on channel capacity, elements of Shannon's theorem and its implications - Problems of communicating in presence of noise - Modulation: Amplitude, angle and phase modulations, single and vestigial sideband forms - demodulation, Super heterodyne principle, automatic gain and frequency control, typical circuit arrangements.

UNIT II PULSE MODULATION, TRANSMISSION AND PERFORMANCE 10

sampling principles, sampling criterion, quantization and quantization noise, selection of number and distribution of quantization levels, bandwidth requirements, examples of coding and decoding circuits. Transmission lines and their circuit representation, characteristic impedance, complex propagation constant, standing wave radio, matching and impedance charts - Channel Amplitude and phase distortion, phase and group delay distortion caused by multiple effects. Noise, origin, measurements, noise figure and noise temperature effect on channel performance - Frequency and time division multiplexing

UNIT III RADIATION AND PROPAGATION 8

Principles: application of basic formulae for unipole and dipole, aerials, effective height, directional, properties, gain, impedance, linear arrays, traveling wave aerials, rhombicas, parasitic elements - Influence of ionosphere and troposphere reflection from earth's surface, field strength calculations, fading diversity reception.

UNIT IV SPECIAL SYSTEMS 9

VHF, UHF, Fibre optics and Laser Technology, Satellite communication and related equipment, electronic counter measures, low-level TV and Head-down displays, CR T displays, Direction finding. Air borne telemetry systems. Laser and infrared systems, Air data and flight recording systems. Satellite communication, spread spectrum technology: satellite transponders, earth terminals

UNIT V SURVEILLANCE AND FLIGHT CONTROLSYSTEM 9

Introduction, secondary radar, The mode S system, Performance determination, Traffic Alert and Collision Avoidance System (TCAS), Weather Radar, checking weather Radar operation, Low-frequency weather mapping systems, roll channel operation, pitch channel operation, yaw channel operation, Autopilot system, Air data computers

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- identify the hardware required for aircraft.
- develop the knowledge about the digital avionics architecture
- perform the autopilot and cockpit display related concepts.
- elaborate the needs of avionics systems used in aircrafts.
- identify the communication and navigation techniques used in aircrafts.

TEXT BOOKS

1. Mike Tooley and David Wyatt "Aircraft communication and Navigation system", Elsevier first edition 2007
2. Albert D.Helfrick, "Modern Aviation Elecronics", Pearson Education, 2nd Edition,2008.

REFERENCES

1. Cary R .Spitzer, "The Avionics Handbook", CRC Press, 2000.
2. Brain Kendal, "Manual of Avionics", The English Book House, 3rd Edition, New Delhi, 1993
3. Jim Curren, "Trend in Advanced Avionics", IOWA State University, 1992.

WEB LINKS

1. http://nptel.ac.in/courses/101105059/
2. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-100-aerodynamics-fall-2005/lecture-notes

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	-	2	-	-	-	2	-	2	2	3	3
CO2	3	2	3	3	3	3	-	-	-	-	3	-	3	2
CO3	2	2	3	3	2	3	-	-	3	-	2	2	2	3
CO4	-	1	3	2	2	2	-	-	3	-	3	2	2	2
CO5	-	3	-	3	2	2	-	-	3	-	3	2	3	2

AE16154 AIR TRAFIC CONTROL AND PLANNING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- study the procedure of the formation of aerodrome and its design.
- learn about the various maintenance activities for airport maintenance.
- understand the air traffic control, procedure and air traffic service.
- familiarize the procedure of the formation of aerodrome and its design and air traffic control.
- acquire the knowledge about the various navigation and lightning facilities.

UNIT I BASIC CONCEPTS 9

Objectives of ATS - parts of ATC service - scope and provision of ATCS -VFR and IFR operations - classification of ATS air spaces -varies kinds of separation - altimeter setting procedures – Establishment designation and identification of units providing ATS -division of responsibility of control.

UNIT II AIR TRAFFIC SERVICES 9

Area control service, assignment of cruising levels minimum flight altitude ATS routes and significant Points RNAV And RNP - Vertical, lateral and longitudinal separations based on time distance - ATC Clearances flight plans - position report. Comparison of various ATC services.

UNIT III FLIGHT INFORMATION, ALERTING SERVICES, COORDINATION, EMERGENCY PROCEDURES AND RULES OF THE AIR 9

Flight Information, Alerting Services, Coordination, Emergency Procedures and Rules of the Air Radar service basic radar terminology - identification procedures using primary / secondary radar - performance checks use of radar in area and approach control services - assurance control and coordination between radar and non radar control - emergencies - flight information and advisory service - alerting service and emergency procedures - rules of the air. Study about communication between aircraft and ATC.

UNIT IV AERODROME DATA, PHYSICAL CHARACTERISTICS AND OBSTACLE RESTRICTION 9

Aerodrome data - basic terminology - aerodrome reference code - aerodrome reference point -aerodrome elevation - aerodrome reference temperature - instrument runway, physical characteristics; length of primary / secondary runway - width of runways - minimum distance between parallel runways etc – obstacles restriction. Comparison between domestic and international airports.

UNIT V VISUAL AIDS FOR NAVIGATION, VISUAL AIDS FOR DENOTING OBSTACLES EMERGENCY AND OTHER SERVICES 9

Visual aids for navigation wind direction indicator - landing direction indicator - location and characteristics of signal area - markings, general requirements - various markings - lights, general requirements – aerodrome beacon, identification beacon - simple approach lighting system and various lighting systems - VASI and PAPI - visual aids for denoting obstacles; object to be marked and lighter - emergency and other services.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- exhibit the concept of air traffic rules and clearance procedures for airline operation.
- analyze the various air traffic data for air traffic services.
- elaborate the influence of aerodrome design factors for service establishments.
- gain knowledge on aerodrome design.
- compare the different services of Air Traffic Control.

TEXT BOOKS

1. Virendra kumar and Sathish Chandra, "Airport Planning and Design", Galgotia publications Pvt Ltd, New Delhi, 2012.
2. Aeronautical Information Publication (India) Vol. I and II, the English book store, 17-1, Connaught New Delhi, 2006

REFERENCES

1. Nolan M. S, "Fundamentals Air Traffic Control", Latest Edition, YESDEE Publishers, 2010
2. Seth B. Young, Alexander T. Wells, "Airport Planning and Management" McGraw-Hill Education, New 2011.

WEB LINKS

1. http://nptel.ac.in/courses/105101008/downloads/cete_40.pdf
2. http://nptel.ac.in/courses/105107123/40
3. http://nptel.ac.in/courses/108105057/Pdf/Lesson-28.pdf

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	3	3	2	-	3	-	-	-	-	2	3	3
CO2	-	2	2	3	3	-	2	-	-	-	-	2	3	2
CO3	-	2	3	3	2	-	2	-	-	-	-	2	2	3
CO4	-	3	2	2	3	-	3	-	-	-	-	2	2	2
CO5	-	3	3	2	3	-	3	-	-	-	-	2	3	2

PROGRAMME ELECTIVE II

AE16251 INDUSTRIAL AERODYNAMICS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- introduce the basic concepts of wind energy collectors.
- understand the aerodynamics of ground vehicles.
- gain the basic concepts of building aerodynamics.
- build up necessary features for induced vibrations.
- acquire knowledge about the industrial gas turbines.

UNIT I WIND ENERGY COLLECTORS 9

Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height. Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.

UNIT II GROUND VEHICLE AERODYNAMICS 9

Power requirement and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of cars, trains and hovercraft.

UNIT III BUILDING AERODYNAMICS 9

Pressure distribution on low rise buildings, Wind forces on buildings, Environmental winds in city blocks, Special Problems of tall buildings, Building codes, Building ventilation and Architectural aerodynamics.

UNIT IV FLOW INDUCED VIBRATIONS 9

Effect of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Buffeting, Vortex Shedding, Galloping and flutter.

UNIT V INDUSTRIAL GAS TURBINES 9

Working of gas turbines, Special features of industrial and stationary gas turbines as compared to aircraft gas Turbines.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- exhibit the basic components and functions of wind energy collectors
- elaborate the aerodynamic performance of ground vehicles.
- analyze about the aerodynamics of various building
- identify the effects and functions of induced vibrations
- classify the subsystem of Industrial turbines.

TEXT BOOKS

1. T. Yomi Obidi, "Ground Vehicle Aerodynamics with Applications", SAE International, 2014.
2. Lawson,"Building Aerodynamics", Cambridge University Press, 2010.

REFERENCES

1. Tomomichi Nakamura, Shigehiko Kaneko, "Flow-Induced Vibrations: Classifications and Lessons From Practical Experiences", Second Edition, Academic Press, 2013.

2. A. R. Jha, "Wind Turbine Technology", CRC Press, 2010.

WEB LINKS

1. http://www.wind-power-program.com/betz.htm
2. https://ntl.bts.gov/DOCS/ch2.html

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	3	-	2	-	-	-	2	2	3	3
CO2	3	3	2	3	2	-	2	-	-	-	3	2	3	2
CO3	2	2	3	2	3	-	3	-	-	-	3	2	2	3
CO4	3	2	3	2	3	-	3	-	-	-	3	2	2	2
CO5	3	1	3	2	3	-	3	-	-	-	2	2	3	2

AE16252 EXPERIMENTAL AERODYNAMICS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- introduce the students about the practical elements of experimental aerodynamics and to develop an appreciation for how aerodynamic data are acquired.
- gain a working knowledge of experimental test facilities, techniques and equipment commonly used in the field of experimental aerodynamics
- present the flow visualization techniques involved in aerodynamic testing
- understand the instruments which is used to measure the physical properties such velocity, pressure and temperature
- provide the students with an opportunity to apply modern instrumentation and measurement techniques to the acquisition of aerodynamic data

UNIT I BASIC MEASUREMENTS IN FLUID MECHANICS 9

Objective of experimental studies, Fluid mechanics measurements, Properties of fluids, Measuring instruments Performance terms associated with measurement systems, Direct measurements, Analogue methods, Flow visualization, Components of measuring systems, Importance of model studies, Experiments on Taylor Proudman theorem and Ekman layer.

UNIT II WIND TUNNEL MEASUREMENTS 9

Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels ,Power losses in a wind tunnel, Instrumentation and calibration of wind tunnels, Turbulence - Wind tunnel balance, Principle and application and uses.

UNIT III FLOW VISUALIZATION AND ANALOGUE METHODS 9

Visualization techniques, Smoke tunnel, Hele-Shaw apparatus, Interferometer, Fringe-Displacement method, Shadowgraph, Schlieren system, Background Oriented Schliren (BOS) System, Hydraulic analogy, Hydraulic jumps, Electrolytic tank.

UNIT IV PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS 9

Pitot-Static tube characteristics, Velocity measurements, Hot-wire anemometry, Constant current and Constant temperature Hot-Wire anemometer, Hot-film anemometry, Laser Doppler Velocimetry (LDV), Particle Image Velocimetry (PIV), Pressure Sensitive Paints, Pressure measurement techniques. Pressure transducers, Temperature measurements.

UNIT V DATA ACQUISITION SYSTEMS AND UNCERTAINTY ANALYSIS 9

Data acquisition and processing Signal conditioning, Estimation of measurement errors, Uncertainty Calculation. Uses of uncertainty analysis.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- execute the basic measurements used in aerodynamics
- operate different types of wind tunnels and calibration of the instruments associated with them.
- elaborate the various instruments used in wind tunnel.

- identify the various instruments used to measure the air properties
- analyze the uncertainty situations by using instruments.

TEXT BOOKS

1. F Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids", CRC Press - Taylor. and Francis, 2007
2. Robert B Northrop, "Introduction to Instrumentation and Measurements", Second Edition, CRC Press,

REFERENCES

1. Pavian, Henry Christensen, "Experimental Aerodynamics", 1st edition, Pitman Pub, 2006
2. G P Russo, "Aerodynamic Measurements: From Physical Principles to Turnkey Instrumentation", publishing, 2011

WEB LINKS

1. http://nptel.ac.in/courses/101106040/
2. http://soliton.ae.gatech.edu/labs/windtunl/

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	-	2	-	2	-	-	2	3	3
CO2	2	3	2	3	2	-	2	-	-	-	-	3	3	2
CO3	-	2	3	2	3	-	3	-	3	-	-	2	2	3
CO4	3	2	3	2	3	-	2	-	3	-	-	2	2	2
CO5	2	1	3	3	2	-	3	-	2	-	-	2	3	2

AE16253 **HYPERSONIC AERODYNAMICS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- introduce the basic concepts of hypersonic aerodynamics
- understand the methods for hypersonic inviscid flows
- know about the viscous hypersonic flow theory
- build up necessary features for viscous interactions in hypersonic flows
- study about the high temperature effects in hypersonic flows

UNIT I FUNDAMENTALS OF HYPERSONIC AERODYNAMICS **9**

Introduction to hypersonic aerodynamics, differences between hypersonic aerodynamics and supersonic aerodynamics, concept of thin shock layers and entropy layers, hypersonic flight paths, hypersonic similarity parameters, shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT II SIMPLE SOLUTION METHODS FOR HYPERSONIC INVISCID FLOWS **9**

Local surface inclination methods, Newtonian theory, modified Newtonian law ,tangent wedge and tangent cone and shock expansion methods, approximate methods, hypersonic small disturbance theory, thin shock layer theory.

UNIT III VISCOUS HYPERSONIC FLOW THEORY **9**

Boundary layer equations for hypersonic flow, hypersonic boundary layers, self similar and non self similar boundary layers, solution methods for non self similar boundary layers, aerodynamic heating and its adverse effects on airframe.

UNIT IV VISCOUS INTERACTIONS IN HYPERSONIC FLOWS **9**

Introduction to the concept of viscous interaction in hypersonic flows ,Strong and weak viscous interactions , hypersonic viscous interaction similarity parameter , introduction to shock wave boundary layer interactions.

UNIT V HIGH TEMPERATURE EFFECTS IN HYPERSONIC FLOWS **9**

Nature of high temperature flows, chemical effects in air, real and perfect gases, Gibb"s free energy and entropy , chemically reacting boundary layers , recombination and dissociation.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- exhibit the components and functions hypersonic aerodynamics
- carry out the aerodynamic performance of hypersonic inviscid flows
- elaborate the viscous hypersonic flow theory
- identify the effects and functions of viscous interactions in hypersonic flows
- identify the effects and functions of viscous interactions in hypersonic flows

TEXT BOOKS

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

REFERENCES

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

WEB LINKS

1. http://nptel.ac.in/courses/101103003/
2. https://arc.aiaa.org/doi/abs/10.2514/3.25879

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	-	2	-	2	-	-	2	3	3
CO2	2	3	2	3	2	-	2	-	-	-	-	3	3	2
CO3	-	2	3	2	3	-	3	-	3	-	-	2	2	3
CO4	3	2	3	2	3	-	2	-	3	-	-	2	2	2
CO5	2	1	3	3	2	-	3	-	2	-	-	2	3	2

AE16254 **WIND TUNNEL TECHNIQUES** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- know the importance of non dimensional number
- understand the application of various types of wind tunnels
- learn the basic measurement procedure involving wind tunnel testing
- interpret the basic concepts of measurement of forces and moments on models during the wind tunnel
- perform the flow visualization

UNIT I PRINCIPLES OF MODEL TESTING **8**

Methods of Dimension analysis- Buckingham - theorem - non-dimensional numbers - model laws - Scale effect and types of similarities

UNIT II WIND TUNNELS **9**

Classification - special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions - layouts - sizing and design parameters

UNIT III CALIBRATION OF WIND TUNNEL **9**

Test section speed - horizontal buoyancy - flow angularities - turbulence measurements – associated instrumentation - calibration of supersonic tunnels

UNIT IV WIND TUNNEL MEASUREMENTS **10**

Pressure and velocity measurements - force measurements - three component and six component balances - internal balances

UNIT V FLOW VISUALIZATION **9**

Smoke and tuft grid techniques - Water flow visualization method - dye injection special techniques -optical methods of flow visualization

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- analyze the methods of dimensional analysis
- acquire knowledge about wind tunnel
- calibrate the wind tunnel
- understand the wind tunnel measurement
- visualize the flow over the component by using various techniques

TEXT BOOKS

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

REFERENCES

1. Rae, W.H. and Pope, A. "Low Speed Wind Tunnel Testing", John Wiley Publication, 2003
2. Robert B Northrop, "Introduction to Instrumentation and Measurements", Second Edition, CRC Press, Taylor and Francis, 2006
3. Antonio Viviani, Giuseppe Pezzella, "Aerodynamic and Aero thermodynamic Analysis of Space Mission

Vehicles", Springer Aerospace Technology, 2015

4. Pavian, Henry Christensen, "Experimental Aerodynamics", 1st edition, Pitman Publishing, 2001.
5. F Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids", CRC Press - Taylor and Francis, 2007.

WEB LINKS

1. http://nptel.ac.in/courses/101106040/8

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	2	3	3	-	-	-	3	2	-	2	3	2
CO2	1	3	2	2	2	-	-	-	1	2	-	1	2	3
CO3	2	2	2	3	1	-	-	-	-	-	-	3	2	3
CO4	3	2	3	3	2	-	-	-	-	-	-	3	2	3
CO5	3	2	1	2	2	-	-	-	-	-	-	3	3	3

OPEN ELECTIVE I

AE16901 AIRCRAFT RULES AND REGULATIONS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the responsibility of owner / operator / CAR of aircraft
- learn the procedure for the preparation of aircraft maintenance and TBO
- enhance the knowledge on various procedures for issue and revalidation of organization certifications
- understand the procedures for various classifications and inspection procedures
- know the various logbook, documents used in aircrafts and its importance

UNIT I C.A.R. SERIES 'A' and C.A.R. SERIES 'B' 9

Introduction to FAA – IATA regulations and its relevance to CAR – Responsibilities of operators / owners – Procedure of CAR issue, amendments etc., Objectives and targets of airworthiness directorate – Airworthiness regulations and safety oversight of engineering activities of operators - Issue Approval of Cockpit check list - MEL, CDL: Deficiency list (MEL and CDL) – Preparation and use of cockpit checklist and emergency list.

UNIT II C.A.R. SERIES 'C' and C.A.R. SERIES 'D' 9

Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-flight readings and recordings; Maintenance control by Reliability. Method. Reliability Programmes (Engines) – Aircraft maintenance programme and their approval – On condition maintenance of reciprocating engines – TBO – Revision programme – Maintenance of fuel and oil uplift and consumption records – Light aircraft engines – Fixing routine maintenance periods.

UNIT III C.A.R. SERIES 'E' and C.A.R. SERIES 'F' 9

Approval of organizations in categories A, B, C, D, E, F, and G – Requirements of infrastructure at stations other; than parent base. Procedure relating to registration of aircraft; Procedure for issue / revalidation of Type Certificate of aircraft and its engines / propeller; Issue / revalidation of Certificate of Airworthiness Requirements for renewal of Certificate of Airworthiness.

UNIT IV C.A.R. SERIES 'L' and C.A.R. SERIES 'M' 9

Issue of AME License, its classification and experience requirements, Mandatory / Inspections.

UNIT V C.A.R. SERIES 'X' 9

Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits and to be Physician"s kit in an aircraft; Use furnishing materials in an aircraft; Concessions; Aircraft log books; Document carried on board on Indian registered aircraft; Procedure for issue of tax permit.

TOTAL PERIODS 45

COURSE OUTCOMES

After successful completion of this course, the students should be able to

- identify the various aviation standards in quality assurance, safety rules and regulations.
- differentiate the certification standards and licensing standards.
- predict various aeronautical organization standards and regulations.
- conclude the Aviation laws and regulations related to each type of organization.
- analyze flight testing certification standards.

TEXT BOOKS

1. „Civil Aviation Requirements with Latest Amendment (Section 2 Airworthiness)", Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi, 2000.
2. FAA, Quality regulation document - VS 1300.2C

REFERENCES

1. Aircraft Manual (India)" – Latest Edition, the English Book Store, 17-1, Connaught Circus, New Delhi.
2. Wg Cdr D P Sabharwal (Retd.), „Q and A – Objective and subjective for CARSection-2".

WEB LINKS

1. http://nptel.ac.in/courses/101104071/
2. http://nptel.ac.in/courses/101106035/001_Chapter%201_L1_(01-10-2013).pdf
3. http://nptel.ac.in/courses/101104071/8

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO3	-	2	3	3	2	-	2	-	-	-	-	2	2	3
CO4	-	3	2	2	3	-	3	-	-	-	-	2	2	2
CO5	-	3	3	2	3	-	3	-	-	-	-	2	3	2

AE16902 **WIND POWER ENGINEERING** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- learn how wind is generated and possible ways of extracting the same.
- estimate the resource potential.
- learn the aerodynamic forces and basics theories of wind turbine.
- make the students to understand the aerodynamic design aspects and controlling methods of wind turbines.
- introduce the environmental aspects of wind energy production.

UNIT I INTRODUCTION TO WINDENERGY **8**

Background, Wind speed variation, Motivations, and Constraints, Historical perspective, Modern wind turbines, Components and geometry.

UNIT II WIND RESOURCES AND CHARACTERISTICS **8**

General characteristics of the wind resource, Atmospheric boundary layer characteristics, Wind data analysis and resource estimation, Wind turbine energy production .

UNIT III WIND TURBINE AERODYNAMICS **11**

Overview , Forces from wind, Lift and Drag forces, Airfoils and aerodynamic concepts ,1-D Momentum theory, Ideal horizontal axis wind turbine with wake rotation, blade element theory, General rotor blade shape performance prediction

UNIT IV WIND TURBINE DESIGN AND CONTROL **9**

Brief design overview, Wind turbine control systems, Typical grid, connected turbine operation, Basic concepts of electric power, Electrical machines.

UNIT V ENVIRONMENTAL SITE AND ASPECTS **9**

Wind turbine siting, Installation and operation, Wind farms, Overview of wind energy Economics, Electromagnetic interference, noise, Safety-Concepts in wind turbine development.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- operate a wind farm and economics of power generation.
- prepare and evaluate detailed project reports for establishing a wind farm.
- elaborate the aerodynamic forces and fundamental theories of wind turbine.
- design and analyze the aerodynamics performance of wind turbines.
- compare the environmental sites and aspects of wind farms.

TEXT BOOKS

1. Emil Simiu and Robert H Scanlan, "Wind effects on structures - Fundamentals and Applications to Design",
   John Wiley and Sons Inc New York, 2016.
2. Ahmad Hemami, "Wind Turbine Technology", Cengage learning, Cananda, 2012.

REFERENCES

1. Tom Lawson, "Building Aerodynamics", Imperial College Press London, 2001
2. G P Russo, "Aerodynamic Measurements: From Physical Principles to Turnkey Instrumentation", Woodhead publishing, 2003.
3. N J Cook, "Design Guides to wind loading of buildings structures- Part I and II", Butterworths London, 2014
4. IS: 875 (1987) Part III Wind loads, Indian Standards for Building codes",2009.

WEB LINKS

1. http://nptel.ac.in/courses/101105059/
2. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-100-aerodynamics-fall-2005/lecture-notes/

Mapping of Course Outcomes with Program Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	Programme Outcomes (POs)												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	3	2	-	2	-	2	-	-	2	3	3
CO2	2	3	2	3	2	-	2	-	-	-	-	3	3	2
CO3	-	2	3	2	3	-	3	-	3	-	-	2	2	3
CO4	3	2	3	2	3	-	2	-	3	-	-	2	2	2
CO5	2	1	3	3	2	-	3	-	2	-	-	2	3	2

AE16903 **AIRCRAFT SAFETY** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- impart the knowledge of human factors and spatial disorientation.
- study the cause of runway incursion.
- gain knowledge of weather related problems in low and high altitudes.
- learn about the various mid air collision issues and rectification procedures.
- know about various air crash investigation reports by NTSB.

UNIT I HUMAN FACTORS **9**

Judgment and Decision Making – Accurate Situation Assessment Leads to good Situational Awareness – Crew Resource Management – Crew effectiveness – Spatial Disorientation – Types of Spatial Disorientation.

UNIT II RUNWAY INCURSIONS **9**

Runway Incursion severity categories – Reported Runway Incursions by Severity – Distribution by Aircraft type and Combination

UNIT III WEATHER **9**

Air Masses and Fronts – Types of Fronts – Cloud Formations – Low, Medium, High clouds – Thunderstorms – Aircraft performance in Heavy rains – Icing conditions – Types of Clouds – Turbulence

UNIT IV MID AIR COLLISIONS **9**

Mid air collision avoidance – Eye brain connection – Eye movement – Distant visual Acuity – Cockpit creates monocular visual areas – Effective scanning based on sectors – Enhancing visual skills.

UNIT V AIR CRSH INVESTIGATION - CASE STUDIES **9**

American Airlines Flight 1420 – USA flight 1493 - Sky west flight 5569 - Delta Airlines flight 191 – Air France flight 4590 - TWA flight 800.

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- compare the features of various human factors.
- describe the principle and avoidance of runway incursion.
- analyze the various weather problems during VFR and IFR flight.
- acquire and interpret data of various mid air collisions.
- acquire knowledge of old air crash and investigation procedures.

TEXT BOOKS

1. Krause, Shari Stamford, Air Safety/ Accident Investigation, analysis and applications, Tata McGraw Hill, New Delhi, 2009 .

REFERENCES

1. Seth B. Young, Alexander T. Wells, "Airport Planning and Management" McGraw- Hill Education, New Delhi, 2011.
2. M.S Nolan, "Fundamentals Air Traffic Control", Latest Edition, YESDEE Publishers, 2010

WEB LINKS

1. http://nptel.ac.in/courses/101106035/001_Chapter%201_L1_(01-10-2013).pdf
2. http://www.nptel.ac.in/courses/112102107/16
3. http://nptel.ac.in/courses/112107143/40

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CO3	-	2	3	2	3	-	3	-	3	-	-	2	2	3
CO4	3	2	3	2	3	-	2	-	3	-	-	2	2	2
CO5	2	1	3	3	2	-	3	-	2	-	-	2	3	2

AE16904 **ACTIVE CONTROL TECHNOLOGY** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- understand the advanced concepts in Active Control Technology to the engineers
- provide the necessary mathematical knowledge that are needed in modeling physical processes
- have an exposure on various topics such as Automatic configuration management, design considerations
- know fly-by-wire concepts, flying qualities and contrsol modes of combat aircraft
- deploy these skills effectively in the solution of problems in avionics engineering

UNIT I ACTIVE CONTROL FUNCTIONS **9**

Introduction-active control technology concepts-control configured vehicle-Design Philosophy, Aerodynamics: Relaxed static stability, Automatic Configuration management, side force control. Structures, Manoeuvre load control, Gust load alleviation, Ride smoothing, fatigue alleviation, Flutter-mode control, Propulsion and Flight Control Integration Technology (PROFIT)

UNIT II ACTIVE CONTROL DESIGN CONSIDERATIONS **10**

Stability augmentation, Command augmentation, Control of aircraft center of gravity, Elastic mode stabilization, and Gust load control, Reliability, redundancy

UNIT III FLY-BY-WIRE TECHNOLOGY **8**

Fly-By-Wire concepts. Primary and secondary electrical flight control system, Redundancy and architecture trade studies - analog and digital FBW Systems - Typical fly-by-wire flight control system elements - Application of fly-by-wire technology to civil and military aircraft.

UNIT IV FLYING QUALITIES **9**

Definition, Cooper - Harper rating scale - flying qualities requirements - Relaxed static stability flying qualities requirements - Lower order equivalent systems criteria Neal - Smith criteria.

UNIT V CONTROL MODES OF COMBAT AIRCRAFT **9**

Pitch rate Command - Attitude hold system - Carefree maneuvering - spin-stall prevention and similar. limiting concepts - Combat maneuvers

TOTAL PERIODS 45

COURSE OUTCOMES

At the end of this course, students will be able to

- describe the knowledge of control function
- develop the active control design
- discuss about fly by wire system
- elaborate the needs of flying qualities
- differentiate the control modes used in aircrafts.

TEXT BOOKS

1. AGARD-AG-234, „Active controls aircraft Design", 1978.
2. AGARD-CP-157, „Impact of active control technology in aircraft design", 1975.

REFERENCES

1. AGARD-CP-260, „Stability and control", 1978.
2. AGARD-CP-137, „Advance in Control systems", 1974.
3. AGARD-CP-228, „Structural aspects of active Controls", 1977.

WEB LINKS

1. https://www.sciencedirect.com/science/article/pii/S147466701741086X

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CO3	2	2	2	3	1	-	-	-	-	-	-	3	2	3
CO4	3	2	3	3	2	-	-	-	-	-	-	3	2	3
CO5	3	2	1	2	2	-	-	-	-	-	-	3	3	3