SYLLABUS OF
UNDERGRADUATE DEGREE COURSE

Aeronautical Engineering

Effective for the students admitted in year 2021-22 and onwards.

B.Tech. : Aeronautical Engineering
3rd Year - V Semester

SN	Category	Course Code	Course Title	Hours			Marks			Credit
				L	T	P	IA	ETE	Total	
THEORY										
1	DC	5AR4-01	Introduction to Vibration and Aeroelasticity	3	0	0	30	70	**100**	**3**
2		5AR4-02	Aerodynamics - II	3	1	0	30	70	**100**	**4**
3		5AR4-03	Aircraft Structures	3	1	0	30	70	**100**	**4**
4		5AR4-04	Aircraft Systems	3	0	0	30	70	**100**	**3**
5	DE-I	5AR5-11	Space Mechanics	2	0	0	30	70	**100**	**2**
		5AR5-12	Aircraft General Maintenance Practices							
		5AR5-13	Fatigue and Fracture							
6	DE-II	5AR5-14	Introduction to Aerospace Propulsion	2	0	0	30	70	**100**	**2**
		5AR5-15	Civil Aviation Requirements-I							
		5AR5-16	Non-Destructive Testing and Evaluation							
			Sub Total	**16**	**2**	**0**	**180**	**420**	**600**	**18**
PRACTICAL & SESSIONAL										
7	DC	5AR4-20	Aerodynamics Lab	0	0	2	60	40	**100**	**1**
8		5AR4-21	Aircraft Structures Lab	0	0	2	60	40	**100**	**1**
9		5AR4-22	Aircraft System Lab	0	0	2	60	40	**100**	**1**
10		5AR4-23	Computer Aided Simulation Lab	0	0	2	60	40	**100**	**1**
11	UI	5AR7-30	Professional Training	0	0	2*	60	40	**100**	**3**
12	CCA	5AR8-00	SODECA/NCC/NSS/ ANANDAM/IPR	-	-	-	-	100	**100**	**1**
			Sub- Total	**0**	**0**	**10**	**300**	**300**	**600**	**8**
			TOTAL OF V SEMESTER	**16**	**2**	**10**	**480**	**720**	**1200**	**26**

L = Lecture, **T** = Tutorial, P = Practical, IA=Internal Assessment, ETE=End Term Exam, **Cr**=Credits
***for calculation of contact hours

B.Tech. : Aeronautical Engineering
3rd Year - VI Semester

THEORY											
SN	**Category**	**Course Code**	**Course Title**	**Hours**			**Marks**			**Credit**
				L	**T**	**P**	**IA**	**ETE**	**Total**	
1	DC	6AR4-01	Composite Materials	2	0	0	30	70	**100**	**2**
2		6AR4-02	Aircraft Performance	3	0	0	30	70	**100**	**3**
3		6AR4-03	Aircraft Stability and Control	3	0	0	30	70	**100**	**3**
4		6AR4-04	Elements of Avionics	3	0	0	30	70	**100**	**3**
5		6AR4-05	Helicopter Theory	3	0	0	30	70	**100**	**3**
6	DE	6AR5-11	Aerospace Heat Transfer	2	0	0	30	70	**100**	**2**
		6AR5-12	Civil Aviation Requirements -II							
		6AR5-13	Aircraft Instrumentation and Control Engineering							
			Sub Total	**16**	**0**	**0**	**180**	**420**	**600**	**16**
PRACTICAL & SESSIONAL										
7	DC	6AR4-20	Composite Materials Lab	0	0	2	60	40	**100**	**1**
8		6AR4-21	Aircraft Electrical System Lab	0	0	2	60	40	**100**	**1**
9		6AR4-22	Aircraft Instrument System Lab	0	0	2	60	40	**100**	**1**
10		6AR4-23	Aircraft Radio Navigation Lab	0	0	2	60	40	**100**	**1**
11	UI	6AR7-50	Minor Project	0	0	4*	60	40	**100**	**2**
12	CCA	6AR8-00	SODECA/NCC/NSS/ ANANDAM/IPR	-	-	-	-	100	**100**	**2**
			Sub- Total	**0**	**0**	**12**	**300**	**260**	**560**	**8**
			TOTAL OF VI SEMESTER	**16**	**0**	**12**	**480**	**680**	**1160**	**24**

L = Lecture, **T** = Tutorial, P = Practical, IA=Internal Assessment, ETE=End Term Exam, **Cr**=Credits
*****for calculation of contact hours

5AR4-01: Introduction to Vibration and Aero elasticity

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To get exposure to the Basic level of Vibration Engineering and its application that they would find useful in their disciplines.
2. To impart knowledge on the fundamentals of Vibration Theory.
3. To do the mathematical model for real-world mechanical vibration problems.
4. To familiarize with the multi-degree of freedom systems.
5. To acquire knowledge to obtain a complete solution to mechanical vibration problems using mathematical or numerical techniques.
6. To understand the different Aero-elastic problems.

Course Outcomes

Students will be able to

1. Apply Vibration Engineering ideas to solve practical problems in society.
2. Solve problems in free, free-damped, and forced vibration characteristics of single-degree-of-freedom systems.
3. Analyze the vibration characteristic of multi-degree freedom systems including orthogonality conditions.
4. Apply the vibration characteristics of the continuous system such as strings bar, shafts, and beams in real-time applications.
5. Calculate the fundamental frequency of multi-degree-of-freedom systems using approximate methods.
6. Investigate the aeroelastic effects of 2D wings.

S. No	Contents	Hours
1	**Introduction:** Vibration – Terms and Definitions, Types, Method of Vibration analysis, Parts of Vibrating System, Fourier series and harmonic analysis.	7
2	**Single Degree of Freedom:** Introduction to simple harmonic motion, D'Alembert's principle, free vibrations, damped vibrations, Differential equation damped free vibration, Torsional vibration, Equivalent stiffness of Spiring combinations, forced vibrations, with and without damping, Types of damping, Logarithmic decrement, support excitation, transmissibility, vibration measuring instruments.	9
3	**Multi Degree Freedom** Two degrees of freedom systems, static and dynamic couplings, vibration absorber, Multi degree of freedom systems, principal coordinates, principal modes and orthogonal conditions, Holzer's method, Stodola method, Eigen value problems, Hamilton's principle, Lagrangean equations, and application.	9
4	**Continuous System** Vibration of strings, longitudinal, lateral and torsional vibrations.	6

5	**Approximate Methods:** Rayleigh's method, Dunkerley's method, Rayleigh-Ritz method, matrix iteration method.	5
6	**Introduction to Aero-Elasticity:** Introduction to Aeroelasticity, Vibration due to coupling of bending and torsion, classification and solution to Aeroelastic problems, collars triangle, wing divergence, aileron control reversal, flutter, U g method, P k method, buffeting. Elements of servo elasticity	4

TEXT BOOKS

1. Singh V P.; "Mechanical Vibration"; Dhanpat Rai & CO; 5th Edition, 2015.
2. Rao.S Singiresu;" Mechanical Vibrations"; Addison Wesley Longman; 5th Edition, 2003.
3. Tongue H Benson; "Principles of Vibration"; Oxford University Press; 2nd Edition, 2002.
4. Wright .R Jan and Cooper. E Jonathan; "Introduction to Aircraft Aero elasticity and Loads"; John wiley & sons, Ltd; 2nd Edition, 2007.

REFERENCE BOOKS

1. Kelly; "Fundamentals of Mechanical Vibrations"; Mc Graw Hill Publications; 2nd Edition, 2000.
2. Thomson W.T.; "Theory of Vibration with Applications"; CBS Publishers and Distributers, New Delhi; 6th Edition, 2002.
3. Thomson William T. and Dahleh, Marie Dillon; "Theory of Vibration with Applications"; Prentice Hall Publishers; 5th Edition,1997.
4. Rao V. Dukkipati, Srinivas. J.; "Vibrations: problem-solving companion"; Narosa Publishers; 5th Edition, 2007.
5. Hodges Deway H.; "Introduction to Structural Dynamics and Aero-Elasticity"; Cambridge University Press; 1st Edition, 2002.

5AR4-02: Aerodynamics-II

Credit: 4Max **Marks: 100(IA: 30, ETE: 70)**

3L+1T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To know the basic concepts & fundamentals of aerodynamics.
2. To learn the concepts of mass, momentum, and energy conservation equations related to Aerodynamics.
3. To gain knowledge on Normal Shocks, Oblique Shocks characteristics, and their impact on Aerodynamics.
4. To impart knowledge on Expansion Waves.
5. To learn the methodology of conformal transformation, the theory of airfoils, and the concept of non-Isentropic 1d Flow.
6. To familiarize with the concept of Experiments in Compressible Flow.

Course Outcomes

Students will be able to

1. Interpret the basic concepts & fundamentals of aerodynamics.
2. Apply the fundamental concepts of mass, momentum, and energy conservation equations for aerodynamic applications.
3. Explain the Normal Shocks, Oblique Shocks characteristics, and their impact on Aerodynamic properties.
4. Analyze the Expansion Waves' characteristics.
5. Solve the problems related to the concepts of vorticity, irrotational, and circulation and Gain insights into thin airfoil theory.
6. Analyze and determine velocity profiles in the laminar and turbulent boundary layers.

S. No	Contents	Hours
1	**Introduction:** Compressibility; Laws of thermodynamics, perfect gas, internal energy, enthalpy, entropy; Mach number, fundamental difference between subsonic and supersonic flow, Mach angle, shock and Mach waves.	3
2	**Steady One-Dimensional Isentropic Flow:** Continuity, momentum and energy conservation equations, Stagnation temperature and pressure, Expression for speed of sound, Area-velocity relation, flow in nozzles& diffusers, effect of back pressure.	5
3	**Normal Shocks:** Normal shock, normal shock relations for perfect gas, Prandtl relation, Rankine-Hugoniot equation; Moving normal shock. **Oblique Shocks:** Oblique shock relations, strong and weak shock solutions, shock polar and detached shock.	12

4	**Expansion Waves:** Expansion fan, Prandtl-Meyer function, and Applications of expansion waves. **Non-Isentropic 1d Flow:** Rayleigh flow (flow with heat addition), Fanno flow (flow with friction).	8
5	**Airfoils in Compressible Flow:** Critical Mach number and critical pressure coefficient, drag divergence Mach number, Shock boundary layer interaction, shock induced separation, White comb area rule, supercritical airfoil, swept and delta wings, supersonic aerofoils, wave drag, Similarity rules, Supersonic thin airfoil theory.	6
6	**Experiments in Compressible Flow:** Transonic, supersonic and hypersonic tunnels and their peculiarities, Blow down, and continuous wind tunnels, Shock tubes, Pressure measurement, Velocity measurement, Optical methods of flow visualization.	6

TEXT BOOKS

1. Anderson John D., Jr.; "Fundamentals of Aerodynamics"; McGraw-Hill publications; 8th Edition, 2016.
2. Rathakrishnan E.;"Theoretical Aerodynamics"; John Wiley & Sons; 1stEdition, 2013.
3. Schlichting Herrmann; Gersten, Klaus -"Boundary Layer Theory"; Springer-Verlag; 9th edition, 2017

REFERENCE BOOKS

1. Houghton E L and Carpenter PW; "Aerodynamics for Engineering students"; Edward Arnoldpublications; 6th edition, 2012.
2. Milne Thomson L.M; "Theoretical Aerodynamics"; 1stEdition, 1996.
3. Roskam Jan, Chuan-Tau Edward Lan ; "Airplane Aerodynamics and Performance"; DAR Corporation, 1stEdition, 1997.
4. Bertin John J; "Aerodynamics for Engineers"; Edward Arnold publications; 6th edition, 2012.

5AR4-03: Aircraft Structures

Credit: 4Max **Marks: 100(IA: 30, ETE: 70)**

3L+1T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To familiarize the student, the generalized theory of pure bending and work out problems in the calculation of bending stress involving different methods.
2. To gain knowledge in the concept of shear flow in thin-walled sections.
3. To carry out shear flow analysis involving different types of sections.
4. To Impart theoretical knowledge on the behavior of thin plates and thin-walled columns.
5. To carry out basic stress analysis procedures involving aircraft structural components.
6. To get exposure on Aircraft Structures-II and its application that they would find useful in their disciplines.

Course Outcomes

Students will be able to

1. Analyze and investigate the normal stress variation on unsymmetrical sections subjected to bending moments.
2. Determine the shear flow variation in thin-walled open sections with skin effective and ineffective in bending. Also to find out the shear center of sections.
3. Calculate the shear flow variation in single-cell and multicell tubes subjected to shear and torque loads.
4. Investigate the behavior of buckling of simply supported plates and also to know the effective width of sheet stringers combination.
5. Solve the problems related to the shear and bending moment variation of aircraft wing and fuselage also to know the characteristics of thin webbed beams.
6. Apply Aircraft Structures-II ideas to solve practical problems in the society.

S. No	Contents	Hours
1	**Introduction:** Features of aircraft structures, monocoque and semi-monocoque structures, Idealization nomenclature and layout function, static equilibrium, statically determinate and indeterminate structures. Concept of static stability. Maxwell's reciprocal theorem.	6
2	**Unsymmetrical Bending:** General, Principal axis and neutral axis methods, bending stresses in beams of symmetric sections with skew loads, Bending stresses in beams of unsymmetrical sections.	7
3	**Shear Flow in Open Sections:** Thin-walled beams, Concept of shear flow, shear centre, Elastic axis with one axis of symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections.	7
4	**Shear Flow in Closed Sections:** Bredt – Batho formula, Single and multi-cell structures, Shear flow in single & multicell structures under torsion. Shear flow in single and multicell under bending with walls is effective and ineffective.	8

5	**Buckling of Plates:** Rectangular sheets under compression, local buckling stress of thin-walled section Crippling stresses by Needham's and Gerard's methods, Thin-walled column	6
6	**Stress Analysis in Wing And Fuselage:** Shear resistant web beams-Tension field web beams (Wagner's), Loads on aircraft, lift distribution, V-n diagram, Gust loads.	6

TEXT BOOKS

1. Donaldson B K.; "Analysis of Aircraft Structures"; Cambridge Aerospace Series; 2nd Edition, 2008.
2. Megson, T.H.G.; "Aircraft Structures for Engineering Students"; Elsevier Ltd; 2nd Edition 2010

REFERENCE BOOKS

1. Sun C T; "Mechanics of Aircraft Structures"; Wiley India; 2nd Edition; 2010.
2. Peery, D.J; "Aircraft Structures"; McGraw–Hill, N.Y.; 2nd Edition, 2011.
3. Stephen P. Timoshenko & S.Woinovsky Krieger;" Theory of Plates and Shells"; McGraw-Hill,Singapore; 2nd Edition, 1990.
4. Rivello R.M.; "Theory and Analysis of Flight structures"; McGraw-Hill, N.Y.; 1st Edition, 1993.

5AR4-04: Aircraft System

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To learn about the construction and working principle of an aircraft's conventional control system and engine control systems.
2. To impart knowledge on the functions of various types of aircraft communication and navigation systems.
3. To familiarize with various hydraulic & pneumatic systems of an aircraft and operation of aircraft landing gear system.
4. To give exposure to various types of Fuel Systems used on an aircraft.
5. To make the students familiarize with the concepts of operation of various auxiliary system.
6. To make students learn the general maintenance practices on aircraft.

Course Outcomes

Students will be able to

1. Interpret the construction and working principle of conventional control system and engine control systems of an aircraft.
2. Explain the functions of various types of modern control system
3. Compare the features of various hydraulic & pneumatic systems of an aircraft and operation of aircraft landing gear system.
4. Analyze the performance of various types of Fuel Systems used on an aircraft.
5. Identify the various auxiliary systems and its operation in an aircraft.
6. Describe the general maintenance practices carried out on an aircraft.

S. No	Contents	Hours
1	**Introduction** **Airplane Control Systems** Conventional Systems – Power-assisted and fully powered flight controls – Power actuated systems – Engine control systems – Push-pull rod system – operating principles – Modern control systems – Digital fly-by-wire systems – Autopilot system, Active Control Technology.	8
2	**Aircraft Systems** Hydraulic systems – Study of typical systems - Components Pneumatic systems – Working principles – Typical Pneumatic Power system– Brake system – Components. **Landing Gear Systems** Classification – Shock absorbers – Retractive mechanism. Anti-skid system, wheels, steering systems.	9
3	**Fuel And Engine Systems** Piston and Jet Engines- Fuel systems – Components - Multi-engine fuel systems, – Starting and Ignition systems. Types of fuels, their properties and testing, fuel transfer systems	8

4	**Airconditioning And Pressurizing System** Components and operation of air-conditioning System, Pressurization System, Basic Air Cycle systems – Vapour Cycle Systems, Boot-strap air cycle system **Auxiliary Systems** Oxygen systems, Fire extinguishing, smoke detection, de-icing, and anti-icing systems. Seat Safety System: Ejection seats, survival packs, parachutes, and pilot's personal equipment.	9
5	**Basic Maintenance Practices:** Jacking, leveling and mooring, refueling and defueling of aircraft, safety precautions. Hydraulic and fluid systems precautions against contamination. Identification color coding, symbols and other markings to identify the fluid systems**.**	6

TEXT BOOKS

1. Mekinley J.L. and R.D. Bent; "Aircraft Power Plants"; McGraw Hill; 9th Edition, 1993.
2. Pallet E.H.J.; "Aircraft Instruments & Principles"; Pitman & Co; 1st Edition, 1993.

REFERENCE BOOKS

1. McKinley, J.L. and Bent R.D; "Aircraft Maintenance & Repair", McGraw Hill; 6th Edition, 1993.
2. Teager, S; "Aircraft Gas Turbine technology"; McGraw Hill; 1st Edition, 1997.

5AR5-11: Space Dynamics

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To introduce special needs for manned space missions and pre calculation of space environment to students.
2. To impart the knowledge on basis concepts of space mechanics like Newton's law of gravitation and its applications, reference co-ordinate systems and position vs time relationships of celestial bodies.
3. To acquaint students on the methodologies for computation of satellite orbit perturbations.
4. To elucidate the concepts of space of influence and its purpose in computing interplanetary trajectories to students.
5. To understand the various phases of ballistic trajectories and special features of re-entry phase to students.
6. To gain knowledge on primary level of space dynamics and its application that they would find useful in their disciplines.

Course Outcomes

Students will be able to

1. Acquire knowledge on the unique features of space environment and its effect on space craft and astronauts.
2. Compute position of bodies in orbits in terms of their coordinates with respect to time.
3. Gain insights on the intricate aspects of satellite injectors.
4. Determine and compute interplanetary trajectories.
5. Analyze calculations of all important phases of missile trajectories.
6. Make use of space dynamics ideas to solve the practical problems in their disciplines.

S. No	Contents	Hours
1	**Introduction:** Definition of space, space environment, effect of space environment on materials of spacecraft structure; Solar system, celestial sphere, ecliptic, equatorial plane and equinoxes; History of space exploration, Space missions and role of launch vehicles and spacecraft, different types of earth orbits, types of spacecrafts, spacecraft subsystems; Newton's law of gravitation, Kepler's laws; Vector differentiation, kinematics relative to moving frames	6
2	**Two-Body Problem:** Equation of relative motion, conservation of angular momentum and energy; Different types of trajectories, orbital elements.	5
3	**Orbital Manoeuvres:** Hohmann transfer, Bielliptic transfer, plane change manoeuvres, combined manoeuvres, low thrust transfer manoeuvres, Noncoplanar transfer, Rendezvous missions, interplanetary trajectories, gravity assist trajectories; Orbit perturbations.	6
4	**Rocket Vehicle Dynamics:** Basic functions and features of rockets and missiles, Tsiolkovsky rocket equation, launch vehicle ascent trajectories and its different phases, effect of aerodynamic drag and gravity on ascent mission performance, vertical, inclined and gravity turn trajectories; Static and dynamic stability of rockets,	6

	rocket thrust vector control methods, Concept of multi-staging, series and parallel staging configurations, optimal staging solutions, Re-entry vehicles and missions, aero braking.	
5	**Ballistic Missile Trajectories:** Introduction to ballistic missile trajectories – boost phase – the ballistic phase – trajectory geometry – optimal flights – time of flight – re-entry phase – the position of impact point – influence coefficients.	5

TEXT BOOKS

1. Cornelisse J.W.; "Rocket Propulsion and Space Dynamics";J.W. Freeman & Co.,Ltd, London; 1st edition, 1982
2. Parker, E.R.;"Materials for Missiles and Spacecraft"; Mc.Graw Hill Book Co. Inc.; 1st Edition, 1982.

REFERENCE BOOKS

1. Sutton, G.P.; "Rocket Propulsion Elements"; John Wiley & Sons Inc., New York; 5th Edition, 1993.
2. Willian E. Wiesel; "Space Flight Dynamics"; Create Space Independent Publishing Platform; 3rd Edition,2010,ISBN- 13: 978-1452879598
3. George P. Sutton and Oscar Biblarz ; "Rocket Propulsion Elements"; Wiley India Pvt Ltd; 7th edition, 2010, ISBN-13: 978-8126525775.

5AR5-12: Aircraft General Maintenance Practices

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To impart knowledge on Safety Precautions to be followed while maintenance done in Aircraft and Workshop.
2. To understand the application of various Maintenance Practices Tools used during General Maintenance Practices.
3. To give exposure on Maintenance procedure of various Aircraft Hardware components.
4. To familiarize with various Maintenance Practices on Aircraft Transmission system.
5. To acquire knowledge on the various Material Bonding practices.
6. To Learn about the general Maintenance Procedures in aircraft maintenance.

Course Outcomes

Students will be able to

1. Explain about Safety Precautions to be followed while maintenance done in Aircraft and Workshop.
2. Gain thorough understanding about the application of various Maintenance Practices Tools used during General Maintenance Practices.
3. Demonstrate about the Maintenance procedure of various Aircraft Hardware components.
4. Illustrate the Maintenance Practices on Aircraft Transmission system.
5. Get a clear idea about the various Material Bonding practices.
6. Describe the general Maintenance Procedures in aircraft maintenance.

S. No	Contents	Hours
1	**Introduction** **Safety Precautions-Aircraft and Workshop** Aspects of safe working practices including precautions to take when working with electricity, gases especially oxygen, oils and chemicals. Instruction in the remedial action to be taken in the event of a fire or another accident with one or more of these hazards including knowledge on extinguishing agents.	4
2	**Maintenance Practices Tools** Care of tools, control of tools, use of workshop materials; Dimensions, allowances and tolerances, standards of workmanship, Calibration of tools and equipment, calibration standards. Common hand tool types; Common power tool types, Operation and use of precision measuring tools, Lubrication equipment and methods. Operation, function and use of electrical general test equipment.	5

3	**Aircraft Hardware** Pipes and Hoses: Types of pipes and hoses used in aircraft, Bending and belling/flaring aircraft pipes, Inspection and testing of aircraft pipes and hoses, Installation and clamping of pipes. Springs: Inspection and testing of springs used in aircraft. Bearings: Testing, cleaning and inspection of bearings, Lubrication requirements of bearings, Defects in bearings and their causes.	4
4	**Transmissions** Types of gears used in the aircraft, Inspection of gears, backlash, Inspection of belts and pulleys, chains and sprockets, Inspection of screw jacks, lever devices, push-pull rod systems. Control Cables: Swaging of end fittings, Inspection and testing of control cables, Bowden cables, aircraft flexible control systems.	5
5	**Material Bonding** Sheet Metal: Marking out and calculation of bend allowance, Sheet metal working, including bending and forming, Inspection of sheet metal work. Composite and non-metallic: Bonding practices, Riveting: Riveted joints, rivet spacing and pitch, Tools used for riveting and dimpling, Inspection of riveted joints. Welding, Brazing, Soldering and Bonding, Soldering methods, inspection of soldered joints. Welding and brazing methods, Inspection of welded and brazed joints, Bonding methods and inspection of bonded joints. Inspection methods	4
6	**Maintenance Procedures** Maintenance planning, Modification procedures, Stores procedures, Certification/releaseprocedures, Interface with aircraft operation, Maintenance Inspection/Quality Control/Quality Assurance, Additional maintenance procedures. Control of life limited components	4

TEXT BOOKS

1. Sterkenburg Ronald; "Aircraft Maintenance and Repair"; McGraw Hill, New York; 8th Edition,2019
2. Kroes Watkins Delp;, "Aircraft Maintenance and Repair"; McGraw Hill, New York; 7th Edition, 2013

REFERENCE BOOKS

1. A&P Mechanics,; "Aircraft Hand Book",;F A A Himalayan Book House, New Delhi;1st Edition, 1996
2. Peery David J; "Aircraft Structures"; Dover Publications; 1st Edition, April 2013, ISBN-13: 978-0486485805.

5AR5-13: Fatigue and Fracture Mechanism

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To impart knowledge in structural integrity in the context of fatigue failure.
2. To give exposure in statistical aspects of fatigue behavior.
3. To acquire knowledge in physical aspects of fatigue.
4. To familiarize the student with theoretical fracture mechanics and make him/her competent to carry out simple fracture analysis procedures.
5. To enable the student to appreciate the different aspects of fatigue testing methods.
6. To gain knowledge on primary level of Fracture Mechanics and its application that they would find useful in their disciplines.

Course Outcomes

Students will be able to

1. Develop a solid foundation in the theory, concepts and principles of fracture mechanics.
2. Apply these solutions to guide a corresponding design, manufacture, or failure analysis.
3. Investigate the life of a structure under dynamic loading conditions.
4. Demonstrate the fracture mechanics approach applicable to homogeneous and heterogeneous materials.
5. Explain probalistic approach and development of mathematical models for life prediction of structures and knowledge of safe life and fail safe design.
6. Make use of space dynamics ideas to solve the practical problems in their disciplines.

S. No	Contents	Hours
1	**Introduction** **Fatigue Of Structures:** S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber's stress concentration factors - Plastic stress concentration factors - Notched S.N. curves – Fatigue of composite materials.	5
2	**Elements of Solid Mechanics:** The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation. Airy's function- field equation for stress intensity factor.	5
3	**Stationary Crack Under Loading:** Two dimensional elastic field, Analytical solutions yielding near a crack front- Irwin'sapproximation, plastic zone size, Dugdaale model, determination of J integral and its relation to crack opening displacement.	5
4	**Energy Balance and Crack Growth:** Griffith analysis, stable and unstable crack growth, Dynamic energy balance, crack arrest mechanism, K1c test methods, R curves, determination of collapse load.	5

5	**Fatigue Crack Growth Curve:** Empirical relation describing crack growth law-life calculations for a given load amplitude, effects of changing the load spectrum. Introduction to factors affecting fatigue crack propagation. Introduction to crack propagation in composite materials.	4
6	**Detection of Cracks:** NDT methods. Experimental determination of GIC, KIC, J-Integral and CTOD.	4

TEXT BOOKS

1. Barrois W, Ripely, E.L.; “Fatigue of aircraft structure"; Pergamon press. Oxford; 3rd Edition, 2004.
2. Anderson T. L.; Fracture Mechanics Fundamentals and Applications; CRC Press; 4th Edition, 2017.
3. Kumar Prasanth; “Elements of fracture mechanics"; Wheeter publication; 1st Edition, 1999.

REFERENCE BOOKS

1. Kare Hellan ;”Introduction to Fracture Mechanics”; McGraw Hill, Singapore;1st Edition, 985
2. D. Brock; “Elementary Engineering Fracture Mechanics ”; Maritinus Nijhoff Publishers; 1st Edition, 1982.
3. Rolfe S. T. and Barson, J. M.; “Fracture and Fatigue Control in Structures,” PHI;1st Edition ,1977

5AR5-14: Introduction to Aerospace Propulsion

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To impart knowledge on fundamentals of rocket propulsion
2. To impart knowledge on solid and liquid propulsion systems
3. To impart knowledge on advanced propulsion systems

Course Outcomes

Students will be able to

1. Understand and evaluate the performance of chemical propellant
2. Understand and evaluate the performance of Ramjet and Scramjet engine
3. Select and design a suitable solid rocket motor
4. Select and design a suitable liquid rocket motor
5. Understand the working of sub-systems of the propulsion system.
6. Assess the performance of electric propulsion systems

S. No	Contents	Hours
1	**Introduction** **Ramjet and Scramjet Propulsion:** Operating principle of Ramjet engine – combustion in Ramjet engine- Introduction to hypersonic air breathing propulsion, hypersonic vehicles and supersonic combustion- need for supersonic combustion for hypersonic propulsion – salient features of scramjet engine and its applications for hypersonic vehicles	4
2	**Chemical Rocket Propulsion:** Operating principle – specific impulse of a rocket – internal ballistics – types of igniters- Rocket nozzle classification – air augmented rockets – pulse rocket motors – static testing of rockets & instrumentation –safety considerations	5
3	**Solid Rocket Propulsion:** Salient features of solid propellant rockets – erosive burning in solid propellant rockets – combustion instability – strand burner and T-burner – applications and advantages of solid propellant rockets.	5
4	**Liquid and Hybrid Rocket Propulsion:** Salient features of liquid propellant rockets – selection of liquid propellants – various feed systems and injectors for liquid propellant rockets -thrust control and cooling in liquid propellant rockets and the associated heat transfer problems	5

5	**Hybrid Rocket Propulsion:** Introduction to hybrid rocket propulsion – standard and reverse hybrid systems- combustion mechanism in hybrid propellant rockets – applications and limitations	5
6	**Advanced Propulsion Systems:** Electric rocket propulsion– types of electric propulsion techniques - Ion propulsion – Nuclear rocket – Future applications of electric propulsion systems - Solar sail – current scenario of advanced propulsion projects worldwide.	4

TEXT BOOKS

1. Sutton G.P.Oscar Biblarz; "Rocket Propulsion Elements"; John Wiley & Sons Inc.; New York, 9thEdn, 2016.
2. Cohen, H., Rogers, G.F.C. and Saravanamutoo, H.I.H.; "Gas Turbine Theory"; 7th Edition, Longman Co.,ELBS Ed., 2017

REFERENCE BOOKS

1. Gordon C. Oates.; "Aero thermodynamics of Gas Turbine and Rocket propulsion"; AIAA Education series, New York, 2nd Edition, 1997.
2. Mathur, M., and Sharma, R.P.; "Gas Turbines and Jet and Rocket Propulsion"; standard Publishers New Delhi;2nd Edition, 2014

5AR5-15: Civil Aviation Requirements- I

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To provide knowledge of various aircraft rules and regulations
2. To impart knowledge in methods of maintaining log books.
3. To understand the different terms associated with rules and regulations

Course Outcomes

Students will be able to

1. Knowledge in aircraft rules.
2. Knowledge in civil airworthiness requirements
3. Method of identifying approved material on Aircraft.
4. Method of maintaining the logbook
5. Learn the Condition under which Aircraft is required to be test flown
6. Knowledge in various terms.

S. No	Contents	Hours
1	**Introduction** **Section 2 - Airworthiness:** Knowledge of Aircraft Rules as far as they relate to airworthiness and safety of aircraft. Knowledge of Privileges and responsibilities of the various categories of AME License and approved persons.	4
2	**Series F - Continuous Airworthiness:** Knowledge of "Civil Airworthiness Requirements", "Aeronautical Information Circulars (relating to airworthiness)", "Advisory Circulars" and ame Notices issued by DGCA. Knowledge ofvarious mandatory documents like Certificate of Registration, Certificate of Airworthiness, FlightManual, Export Certificate of Airworthiness.	6
3	**CAR Section 2 - Series X:** Method of identifying approved material on Aircraft. Knowledge of various documents/certificates issued to establish airworthiness of Aircraft parts. Various logbooks required to be maintained for Aircraft. Method of maintaining the logbook. Procedure for making entries in logbooks; Journey logbook, Technical logbook etc. Use of schedules, its certification, preservation.	6
4	**Section 5 - Storage of Aircraft Parts:** Stores: Bonded and Quarantine stores, storage of various aeronautical products including rubber goods, various fluids. Knowledge of various terms such as Certificate of Flight Release, Certificate of Maintenance, Approved Certificates..	5
5	**Series T - Flight Testing of A/C:** Condition under which Aircraft is required to be test flown; Certificate to be issued by AME for test flight. Circumstances under which C of A is suspended. Ferry Flight, MEL, CDL..	5

TEXT BOOKS

1. Civil Aviation Requirements; Section-II by DGCA; Published by English Book Store.
2. Aircraft Manual, the Aircraft Act, 1934.
3. Aeronautical Information Circular, DGCA.

REFERENCE BOOKS

1. Airworthiness Advisory Circular. 2014
2. Aircraft Maintenance Engineers Notices. 2005
3. Kermode AC, “Mechanics of Flight”.

5AR5-16: NDT Testing and Evaluation

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To provide knowledge of various processes involved in non-destructive testing.
2. To impart knowledge in discontinuities in materials.
3. To impart knowledge in NDT application in the Aerospace maintenance field.
4. To understand the different NDT processes.
5. To learn the behavior defects with NDT tools.
6. To understand the knowledge of defects in the Aerospace field.

Course Outcomes

Students will be able to

1. Understanding various types of discontinuities.
2. Knowledge in non – destructive testing, its scope, and purpose.
3. Understand the different NDT processes.
4. Evaluate the properties of the material without causing damage.
5. Learn the dynamic behavior of defects with NDT tools.
6. Choose the best NDT method for different applications.

S. No	Contents	Hours
1	**Introduction of Non-Destructive Testing:** Non-Destructive Testing (NDT) and Destructive. History of Non-Destrictive Testing (NDT). Scope and features of NDT.	4
2	**Visual Inspection and Liquid Penetrant Testing:** Testing, Visual Inspection-Basic principle, Optical aids used for Visual Inspection. Liquid Penetrant Testing- Principles, Procedures, Penetrant Testing Methods, Sensitivity, Applications and Limitations, Standards.	5
3	**Magnetic Particle Testing and Eddy Current Testing:** Magnetizing techniques, Procedures, Equipments for MPT, Sensitivity, and Limitations. Eddy Current Testing –Principles, Instrumentation, Techniques in MPT, Applications and limitations.	5
4	**Radiography:** Electromagnetic Radiation Sources, Radiation attenuation in the specimen, Effect of radiation on film, Radiographic Imaging, Inspection Techniques in Radiography, Applications and limitations.	5
5	**Acoustic Emission Testing and Ultrasonic Testing:** Instrumentation of Acoustic Emission Technique, Sensitivity, Applications and limitations. Ultrasonic Testing-Basic properties of sound beam, Inspection methods, Techniques for Normal Beam Inspection and Angle Beam Inspection, Modes of display, applications and limitations.	5

6	**Thermography:** History and development, theory and basic principles, Detectors and Equipment, Techniques, Variables, Evaluation of test results and reports, Applications-electronics industry, aerospace applications and electrical applications, advantages and limitations, Standards.	4

TEXT BOOKS

1. Raj Baldev, Jayakumar T., M. Thavasimuthu; "Practical Non-destructive Testing"; Woodhead Publishing; 2nd Edition, 2002.
2. Mix P. E.; "Introduction to non-destructive testing"; Wiley Interscience,, John Wiley &Sons, Inc,Publ.; 2nd Edition, 2005.

REFERENCE BOOKS

1. Gupta Lalith; "Aircraft General Engineering"; Himalaya Book House; Delhi,1st Edition, 2003.
2. Hellier C.; "Handbook of Nondestructive Evaluation"; McGraw-Hill, 1st Edition, 1994.

5AR4-20: Aerodynamics Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To impart knowledge on Flow over aerofoils and wings.
2. To impart knowledge on Forces and moments over an aerofoil.
3. To impart knowledge on Shock wave over various model.

Course Outcomes

Upon successful completion of the course the students will be able to;

1. **CO1:** Understand the aerodynamic variables connected with airflow.
2. **CO2:** Draw pressure distribution over various aerofoils.
3. **CO3:** Visualize subsonic flow over various models.
4. **CO4:** Estimate effect of Reynolds number of low speed airfoil.
5. **CO5:** Evaluate the forces and moments over aircraft model.
6. **CO6:** Visualize shock wave and estimate shock angle over various model**.**

S. No	Contents (Any ten experiments)	Hours
1	Calibration of a subsonic Wind tunnel.	
2	Determination of lift for the given airfoil section.	
3	Pressure distribution over a smooth circular cylinder.	
4	Pressure distribution over a rough circular cylinder.	
5	Pressure distribution over a symmetric aerofoil.	
6	Pressure distribution over a cambered aerofoil.	
7	Force measurement using wind tunnel balancing setup.	
8	Flow over a flat plate at different angles of incidence.	
9	Flow visualization studies in low speed flows over cylinders.	
10	Flow visualization studies in low speed flows over airfoil with different angle of incidence.	

5AR4-21: Aircraft Structures Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To enable the students to understand the behavior of aircraft structural components under different loading conditions.
2. To provide the principle involved in photo elasticity and its applications in stress analysis for composite laminates.

Course Outcomes

Upon successful completion of the course, the students will be able to;

1. **CO 1:** Calculate modulus of elasticity of aluminium material using an electrical extensometer.
2. **CO 2:** Calculate the fracture strength and differentiate fracture pattern of ductile and brittle material.
3. **CO 3:** Calculate the deflection produced due to external load in the beam with different end conditions also verify Maxwell's reciprocal theorem and principal of superposition.
4. **CO 4:** Calculate the compressive strength of short and long column and critical buckling load.
5. **CO 5:** Examine photo elastic technique for the calculation of principal stresses using photo elastic bench.
6. **CO 6:** Calculate the Shear Centre of various types of Section (Open and Close)

S. No	Contents (Any ten experiments)	Hours
1	Verification of Maxwell's Reciprocal theorem & principle of superposition.	
2	Compression tests on long and short columns, Critical buckling loads, South well plot.	
3	Find the deflection using unsymmetrical bending apparatus	
4	Find the elastic properties of deflected beam.	
5	Deflection of beams with various end conditions for different load.	
6	Determination of fracture strength and fracture pattern of ductile & brittle materials.	
7	Determination of Young's modulus of aluminum using electrical extensometers	
8	Determination of flexural rigidity of composite beams	
9	Study the shear center location for open and closed section	
10	Study the Wagner beam-Tension field beam and Photo- elastic bench	

5AR4-22: Aircraft Systems Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To train the students "ON HAND" experience in maintenance of various air frame systems in aircraft and rectification of common snags.
2. To train the students on various system maintenance in aircraft.

Course Outcomes

Upon successful completion of the course, the students will be able to;

1. **CO1:** Perform Jacking and Levelling of an Aircraft
2. **CO2:** Perform Rigging and Symmetry check of an Aircraft
3. **CO3:** Investigate the life of a structure under dynamic loading conditions.
4. **CO4:** Examine hydraulic actuator leakage.
5. **CO5:** Examine various fuel system components and wheel brake units.
6. **CO6:** Make use of "ON HAND" experience in maintenance to solve the practical problems in their disciplines.

S. No	Contents (Any ten experiments)	Hours
1	Performance of "Jacking Up & Leveling" of Aircraft and its procedure	
2	Performance of Control System "Rigging check" and its procedure	
3	Performance of Aircraft "Symmetry Check" and its procedure	
4	"Flow test" to assess of filter element clogging	
5	"Pressure Test" To assess hydraulic External/Internal Leakage	
6	"Functional Test" of Hydraulic Actuator for its proper operation, leakage and load test.	
7	"Pressure Test" procedure on fuel system components	
8	"Brake Torque Load Test" on wheel brake units	
9	Maintenance and rectification of snags in pneumatic, hydraulic and fuel systems components and on Aircraft.	
10	Functional Test of Pressurization System, Fire detection system on aircraft and aircraft landing gear retraction system and its relevant indications in the cockpit.	
11	Functional Test of aircraft landing gear retraction system and its relevant indications in thecockpit.	
12	Functional Test of Fire detection system on aircraft.	

5AR4-23: Computer-Aided Simulation Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To train the students "ON HAND" experience in maintenance of various air frame systems in aircraft and rectification of common snags.
2. To train the students on various system maintenance in aircraft.

Course Outcomes

Upon successful completion of the course, the students will be able to;

1. **CO1:** Perform Jacking and Levelling of an Aircraft
2. **CO2:** Perform Rigging and Symmetry check of an Aircraft
3. **CO3:** Investigate the life of a structure under dynamic loading conditions.
4. **CO4:** Examine hydraulic actuator leakage.
5. **CO5:** Examine various fuel system components and wheel brake units.
6. **CO6:** Make use of "ON HAND" experience in maintenance to solve the practical problems in their disciplines.

S. No	Contents (Any ten experiments)	Hours
1	Grid independence study and convergence test using any simple case like pipe flow, diffuser flow, flow over a cylinder, aero foil etc.	
2	Simulation of flow over backward facing step.	
3	Simulation of Karman vortex trail (vortex shedding) using circular cylinder.	
4	External flow simulation of subsonic and supersonic aero foils.	
5	Internal flow simulation of subsonic, sonic and supersonic flow through a CD nozzle.	
6	Structural analysis of bar, beam and truss.	
7	Structural analysis of tapered wing.	
8	Structural analysis of fuselage structure.	
9	Analysis of composite laminate structures.	
10	Heat transfer analysis of structures.	

6AR4-01: Composite Materials

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To understand with the different types of Composite materials and its application in aviation industry.
2. To get exposure on Basic level of Composite Materials and its application that they would find useful in their disciplines.
3. To impart knowledge on the Manufacturing of Composites materials.
4. To do mathematically model for real-world Elastic Behaviour of Composite Lamina-Micromechanics.
5. To familiarize with the Analysis of Multidirectional Laminates.
6. To acquire knowledge on Mechanical Testing, Failure and Maintenance of Composites materials.

Course Outcomes

Students will be able to

1. Investigate the different types of Composite materials and its application in aviation industry.
2. Apply Composite Materials ideas to solve the practical problems in the society.
3. Solve problems in Manufacturing of Composites materials.
4. Analyze the Elastic Behaviour of Composite Lamina-Micromechanics.
5. Apply the Multidirectional Laminates in real time applications.
6. Calculate the Mechanical Testing, Failure and Maintenance of Composites materials.

S. No	Contents	Hours
1	**Introduction:** Definition, matrix & fibers, various types of matrix materials and their properties, properties of various types of fibers like glass, Kevlar, carbon and graphite. Polymers, properties of polymers like epoxy, polyester and phenolic. Applications of composites with emphasis on Aviation industry	5
2	**Manufacturing of Composites:** Hand lay-up technique, Autoclave moulding, Pressure bag and vacuum bag moulding, Pultrusion, Resin-transfer moulding, Injection moulding, Bulk and sheet moulding compound methods, Prepregs. Short fiber composites, Sandwich structure composites, Honeycomb structure.	5
3	**Elastic Behaviour of Composite Lamina-Micromechanics:** Volume fraction, weight fraction, density of composites, Micromechanics and macromechanics approach, Longitudinal elastic properties, transverse elastic properties, in-plane shear modulus, Poisson's ratio, Elastic Behaviour of Composite Lamina-Macromechanics, Stress- Strain relations of different material projection in Composite materials.	6

4	**Analysis of Multidirectional Laminates:** Laminate orientation code, symmetric and balanced laminate, Introduction to cross-ply, angle-ply and quasi-isotropic laminates, Classical laminate theory, strain-displacement relationship, stress strain relations, force and moment resultants, in-plane and flexural laminate stiffness, Asymmetric laminate and coupling effect, Stress analysis of cross-ply symmetric laminate under in-plane and flexural loading.	6
5	**Mechanical Testing, Failure and Maintenance of Composites:** Tensile testing, Compressive testing, Intra-laminar shear testing, Fracture testing, Impact testing, Fatigue testing. Failure types in laminates; Damage to laminate structures; Inspection Methodology, quality control	6

TEXT BOOKS

1. Autar K Kaw; "Mechanics of Composite Materials"; CRC Press; 2nd edition, 2005.
2. Isaac M. Daniel & Ori Ishai; "Mechanics of Composite Materials"; OUP USA publishers; 2nd edition, 2005.
3. Madhujit Mukhopadhyay; "Mechanics of Composite Materials and Structures"; University Press; 1st edition 2004.

REFERENCE BOOKS

1. Agarwal, B.D., and Broutman, L.J.; "Analysis and Performance of Fibre Composites"; John Wiley & Sons; 3rd edition, July 2006.
2. Allen Baker; "Composite Materials for Aircraft Structure"; AIAA Serie; 2nd Edition, 2004.
3. Calcote, L R; "The Analysis of laminated Composite Structures"; Von – Nostrand Reinhold Company, New York; 1st edition 1998.
4. Lubing, Handbook; "Advanced Plastics and Fibre Glass" Von Nostran Reinhold Co., New York; 1st edition 1989.
5. Michael F. Ashley; "Material Selection in Mechanical Design"; Butterworth-Heiner; 6th edition, 2022.

6AR4-02: Aircraft Performance

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To study behavior of earth's atmosphere.
2. To get exposure on level flight performance.
3. To describe the gliding and climbing flights and the parameters that decide those performance.
4. To understand accelerated flight performance.
5. To introduce the concept of load factor and provide necessary equation to assess the turn performance of an airplane.
6. To acquire theoretical knowledge on High Lift devices basic principle and performance parameters.

Course Outcomes

Students will be able to

1. Predict performance characteristics of physical nature of atmosphere and concepts of EAS, TAS and IAS.
2. Interpret the concept of basic equations governing the steady performance of airplanes.
3. Gain insights into the performance of airplanes during steady glide and climb.
4. Investigate the factors affecting landing and take-off performance of airplanes.
5. Demonstrate about the flight envelope and turning performance of airplanes.
6. Explain the working of High Lift devices and its performance parameters.

S. No	Contents	Hours
1	**Introduction:** Need to define standard atmosphere; International Standard Atmosphere, Stability of Atmosphere, equivalent, calibrated and indicated airspeed, Primary flight instruments, ASI, VSI, turn-bank indicator.	4
2	**Aerodynamic Characteristics:** Forces and moments acting on a flight vehicle, variation of aerodynamic coefficients with angle of attack, Reynolds number and Mach number, Effect of aspect ratio, planform, sweep, taper and twist on aerodynamic characteristics, Different types of drag, drag polar, design methods to reduce drag,	6
3	**Steady and Level Flight:** Equations of motion, Thrust and power required for level unaccelerated flight, Maximum thrust and power available for jet engine and propeller engine, variation of thrust/power available and required with altitude, Maximum level flight speed, conditions for minimum drag and minimum power required, Stalling speed, Range and endurance of jet and propeller engine airplanes, Condition for maximum range and endurance, effect of altitude, weight and wind	6

4	**Climbing Flight:** Unaccelerated climb, Excess power, Maximum rate of climb and steepest angle of climb, time to climb, climb hodograph, Absolute and service ceilings, Accelerated rate of climb, energy approach; Energy maneuverability. **Gliding Flight:** Steady descent, equilibrium glide angle, equilibrium glide velocity, Minimum rate of sink and shallowest angle of glide, maximum gliding range, Glide hodograph.	10
5	**Take-off &Landing Performance:** Equations of motion during take-off and landing, Estimation of take-off and landing distances, Effect of head, tail and cross winds; Auxiliary systems: thrust augmentation, reverse thrust, jet assisted takeoff system, spoilers.	5
6	**Manoeuvring Flight:** Level coordinated turning flight in horizontal plane, bank angle, load factor, V-n diagram, Minimum turn radius, Maximum sustained and attained turn rate, Turn in vertical plane, pull-up andpull-down manoeuvres. **High Lift devices:** Different types of trailing edge flaps, leading edge devices, boundary layer control, powered lift.	9

TEXT BOOKS

1. Anderson J D; "Aircraft performance and Design"; McGraw-Hill, New York; 5th edition 2000.
2. Roskam, Jan and Lan, Chuan-tau E; "Airplane Aerodynamics and Performance"; DAR Corporation, Lawrence, Kansas, USA; 1st edition 1997.

REFERENCE BOOKS

1. Perkins, C D and Hage, R E; "Airplane Performance Stability and Control"; Willey Toppan; 8th edition 2010.
2. Houghton, E L and Carruthers N B; "Aerodynamics for Engineering Students"; Edward Arnold Publishers; 7th edition, 1988.
3. Filippone, A; "Advanced Aircraft Flight Performance" Cambridge University Press; 2nd edition 2012.
4. David G. Hull; "Fundamentals of Airplane Flight Mechanics" Springer-Verlag Berlin Heidelberg; 1st edition 2007.

6AR4-03: Aircraft Stability and Control

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To familiarize the student, the generalized concepts of stability and control in an aircraft.
2. To gain knowledge in the concept of static longitudinal stability and control derivatives, and criteria for a stable airplane.
3. To estimate the maneuvering stability of an aircraft.
4. To Impart theoretical knowledge on the static lateral and directional stability and control derivatives, and criteria for a stable airplane.
5. To carry out the various dynamic instabilities of an aircraft motion.
6. To get exposure on the need and aspects of aerodynamic balancing.

Course Outcomes

Students will be able to

1. Analyze and investigate the generalized concepts of stability and control in an aircraft.
2. Determine the concept of static longitudinal stability and control derivatives, and criteria for a stable airplane.
3. Calculate the maneuvering stability of an aircraft.
4. Investigate the behavior on the static lateral and directional stability and control derivatives, and criteria for a stable airplane.
5. Solve the various dynamic instabilities of an aircraft motion.
6. Apply aspects of aerodynamic balancing ideas to solve the practical problems in the society.

S. No	Contents	Hours
1	**Introduction:** Degrees of freedom of a system, Static stability, dynamic stability, Aircraft stability control, simplifying assumptions, axis of reference and notation, equations of motion, aerodynamic deviations. Longitudinal, lateral and directional stability and control.	4
2	**Longitudinal Static Stability Stick Fixed:** Basic equations of equilibrium, Stability criterion, Wing and tail moments, Effect of fuselage and nacelles, Effect of center of gravity (c.g.) location, Power effects, Stabilizer setting and c.g. location, Elevator effects, stick fixed neutral point.	6
3	**Longitudinal Static Stability Stick Free:** Hinge moment coefficients, Stick free neutral point symmetric maneuvers, stick force gradients and stick force per g. Aerodynamic balancing of control surfaces.	5
4	**Manoeuvering Stability:** The stick-fixed aspect, stick-free aspect, limitations, longitudinal control, elevator and trim tab,stick force and stick gearing, variation of stick force with airspeed, effect of pitching velocity on tail incidence.	6

5	**Directional Static Stability and Control:** Vertical tail contribution, fuselage contribution, wing contribution, propeller effect. Rudder power, yaw damping. Rudder-fixed and rudder free directional stability, asymmetric power, pedal forces, rudder lock.	5
6	**Lateral Static Stability and Control:** Effect of wing location, sweep and dihedral, fuselage and vertical tail, Coupling between rolling and yawing moments; Adverse yaw effects, Aileron reversal. Lateral control power, Roll damping, directional divergence. Different types of trailing edge flaps, leading edge devices, boundary layer control, powered lift.	5
7	**Dynamic Stability and Control:** Euler angles, Equations of motion, stability & control derivatives. Decoupling of longitudinal and lateral-directional dynamics, Longitudinal modes, Lateral-directional modes, Phugoid, Autorotation and spin, Control response, impulse and step response. **Aerodynamic Balancing:** The set-back rings, the horn balance, the aileron, the sealed nose balance and the geared balance tab.	9

TEXT BOOKS

1. Perkins, C D and Hage, R E; "Airplane Performance Stability and Control"; Willey Toppan; 8th edition 2010
2. Nelson, R.C; "Flight Stability and Automatic Control"; McGraw-Hill Book Co; 2nd edition 2014

REFERENCE BOOKS

1. Anderson J D, "Aircraft performance and Design"; McGraw-Hill, New York; 5th edition 2000.
2. Etkin, Bernard, and Lloyd Duff Reid; "Dynamics of Flight Stability and Control"; John Wiley,New York; 3rd edition 1995.
3. Jan Roskam, Roskam J; "Airplane Flight Dynamics and Automatic Flight Controls"; Design, Analysis and Research Corporation; 2nd edition 2018
4. Stevens, B., and F. Lewis; "Aircraft Control and Simulation"; New York: Wiley- Interscience; 2nd edition 2003.
5. Blakelock, John H; "Automatic Control of Aircraft and Missiles"; New York: Wiley- Interscience; 2nd edition 1991.

6AR4-04: Elements of Avionics

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To acquire knowledge on the Basic of the avionics subsystem and antenna theory
2. To impart knowledge and basic digital science and displays used in aircrafts
3. To give exposure to various aircraft Radar Engineering and Microwave Engineering.
4. To familiarize with basic inspections procedures Communication Equipment's and its working.
5. To make students learn the aircraft VHF, ELT, AIS. CVR, FDR systems its working and construction.
6. To understand about the Navigation Systems and GPS Systems in an aircraft.

Course Outcomes

Students will be able to

1. Identify the Basic of the avionics subsystem and antenna theory
2. Explain basic digital science and displays used in aircrafts
3. Summarize the various aircraft Radar Engineering and Microwave Engineering.
4. Illustrate about the basic inspection's procedures Communication Equipment's and its working.
5. Identify the components of aircraft VHF, ELT, AIS. CVR, FDR systems its working and construction.
6. Describe about the operation of Navigation Systems and GPS Systems in an aircraft.

S. No	Contents	Hours
1	**Introduction:** Introduction to Logic gates, encoder, decoder, MUX, DE-MUX, Typical avionics subsystems, and avionics architecture. MIL-STD 1553B Digital Data Buses, Antenna theory, various types of antennas, Refraction and Diffraction phenomenon, clutter signals.	8
2	**Displays:** Cathode Ray Tube (CRT), Active-Matrix Liquid Crystal Display (AMLCD), Head Down Display (HDD), Head Up Display (HUD), Helmet Mounted Display (HMD), Integrated Standby Instrument System (ISIS). Direct voice input (DVI), HOTAS.	4
3	**Radar and Microwave Engineering:** Radar definition, Radar range equation, pulsed, CW, and Doppler Radars Microwave - Various types of radar transmission Lines, Rectangular and circular waveguides, coaxial lines, Devices: Magnetron, Klystron, backward wave oscillator, Travelling wave tubes	4
4	**Communication:** HF, U/VHF, Audio integration system, Satellite Communication, Selcal, Air Traffic Control (ATC) Transponder, Traffic Collision & Avoidance System (TCAS), Identification of Friend & Foe (IFF). Emergency locator transmitters	6
5	**Inertial and Satellite Navigation System:** Global Positioning System (GPS) - Basic principles, position and velocity determination, Signal	8

	structure, Differential GPS, Inertia Navigation system (INS)- INS components: transfer function and errors, The earth in inertial space, the Coriolis effect, and Mechanization. Platform and strap down, INS system block diagram	
6	**Other Navigation System:** Automatic Direction Finding, Very High-Frequency Omni-Range (VOR), Distance Measuring Equipment (DME), Tactical Air Navigation (TACAN), Hyperbolic navigation, Instrument Landing System (ILS), Transponder Landing System (TLS), Microwave Landing System (MLS), Astronavigation, Radar Altimeter (RADALT), Weather Radar.	10

TEXT BOOKS

1. Myron Kayton and Walter R fried; "Avionics Navigation Systems"; John Wiley and Sons; 2nd edition 1997.
2. Powell J; "Aircraft Radio Systems"; Himalayan Books; 1st edition 1990.
3. Tetley L and Calcutt D; "Electronic Aids to Navigation"; Edward Arnold Publishers Ltd; 1st edition 1986.
4. Collinson R.P.G; "Introduction to Avionics Systems"; Springer Science+Business Media B.V; 3rd Edition 2011

REFERENCE BOOKS

1. Ian Moir, Allan Seabridge; "Civil Avionics Systems"; John Wiley & Sons Ltd; 2nd edition 2013
2. Eismin T.K; "Aircraft Electricity & Electronics"; Macmillan; 7th edition 2019.
3. Geroge Kannedy; "Electronic Communication System"; McGraw Hill; 4th edition 1999.
4. Albert Helfrick; "Principle of Avionics"; Avionics Communication INC; 4th Edition, 2007

6AR4-05: Helicopter Theory

Credit: 3Max **Marks: 100(IA: 30, ETE: 70)**

3L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To acquire knowledge on the fundamental aspects on helicopter theory of flight.
2. To give exposure on helicopter rotor aerodynamics, generation of lift and rotor control & efficiency to students.
3. To make students familiarize with the concepts like hovering and vortex ring state and calculation of induced power.
4. To make students knowledgeable on helicopter flight performance calculations and on criteria for selection of power plants.
5. To acquaint students with lateral and longitudinal stability characteristics of helicopter and the differences between stability and control.
6. To elucidate students on the structural problems peculiar to helicopter rotor like rotor vibration.

Course Outcomes

Students will be able to

1. Identify the various theory of flight behind the helicopter.
2. Analysis the Aerodynamics calculation of Rotor blade.
3. Illustrate the stability and control characteristics of Helicopter.
4. Perform and control the Rotor vibration.
5. Explain the stability characteristics of a helicopter.
6. Demonstrates the role of rotor vibrations in helicopter structural design.

S. No	Contents	Hours
1	**Introduction:** Helicopter as an aircraft, Basic features, Layout, Generation of lift, Main rotor, Gearbox, tail rotor, power plant, considerations on blade, flapping and feathering, Rotor controls and various types of rotor, Blade loading, Effect of solidity, profile drag, compressibility etc., Blade area required, number of Blades, Blade form, Power losses, Rotor efficiency.	6
2	**Aerodynamics of Rotor Blade:** Aerofoil characteristics in forward flight, Hovering and Vortex ring state, Blade stall, maximum lift of the helicopter calculation of Induced Power, High speed limitations; parasite drag, power loading, ground effect.	6
3	**Power Plants and Flight Performance:** Piston engines, Gas turbines, Ramjet principle, Comparative performance, Horsepower required, Range and Endurance, Rate of Climb, Best Climbing speed, Ceiling in vertical climb, Autorotation.	5

4	**Stability and Control:** Physical description of effects of disturbances, Stick fixed Longitudinal and lateral dynamic stability, lateral stability characteristics, control response. Differences between stability and control of airplane and helicopter.	5
5	**Rotor Vibrations:** Dynamic model of the rotor, Motion of the rigid blades, flapping motion, lagging motion, feathering motion, Properties of vibrating system, phenomenon of vibration, fuselage response, vibration absorbers, Measurement of vibration in flight. Rotor Blade Design: General considerations, Airfoil selection, Blade construction, Materials, Factors affecting weight and cost, Design conditions,Stress analysis.	6

TEXT BOOKS

1. Anderson J D; “Helicopter Theory”; Wiley; 5th edition 2019.
2. John Fay; "The Helicopter and How It Flies"; Himalayan Books; 1st edition 1995
3. Lalit Gupta; "Helicopter Engineering"; Himalayan Books New Delhi; 1st edition 1996

REFERENCE BOOKS

1. Vannoy A.R; "Helicopter Maintenance"; Jeppesen; 3rd edition 2017
2. Joseph Schafer; "Basic Helicopter Maintenance"; Jeppesen; 6th edition 1980
3. Prouty R W, “Helicopter Aerodynamics”; Phillips Pub Co; 2nd edition 1993.

6AR5-11: Aerospace Heat Transfer

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To impart knowledge to students in the fundamental principles of various numerical methods which are useful to obtain numerical solutions to heat transfer problems.
2. To give exposure on basis concepts of Space Craft Thermal Environments.
3. To acquaint students on the methodologies of Thermal Control Techniques.
4. To elucidate the concepts of Phase Change Materials to students.
5. To understand the various phases of Thermal Contact Resistance and Its Calculation.
6. To gain knowledge on Ablative Heat Transfer and its application in the Aerospace discipline.

Course Outcomes

Students will be able to

1. Explain the fundamental principles of various numerical methods which are useful to obtain numerical solutions to heat transfer problems.
2. Demonstrate the concepts of Space Craft Thermal Environments.
3. Illustrate the methodologies of Thermal Control Techniques.
4. Determine Phase Change properties of Materials used in a space application.
5. Analyze the various phases of Thermal contact resistance.
6. Make use of Ablative Heat Transfer in the Aerospace application.

S. No	Contents	Hours
1	**Introduction:** Launch and ascent environments, environment of earth orbit, environments of interplanetary missions.	5
2	**Thermal Control Techniques:** Passive thermal control techniques: thermal coating materials, thermal insulation, heat sinks, phase change materials, Active thermal control techniques: electrical heaters, thermal louvers, HPR fluid systems, heat pipes, space borne cooling systems. Insulation-Blanket Design: materials-attachment, high temperature blanket, insulation for in atmosphere applications.	6
3	**Phase Change Materials :** When to use a PCM, PCM design. Heat Pipes, Types, Analysis, Testing, heat pipe applications and performances.	5
4	**Thermal Contact Resistance and Its Calculation:** Parameters influencing thermal joint resistance, effect of oxidation and interstitial effects.	6
5	**Ablative Heat Transfer:** Physical process and calculation of ablation rates, hypersonic ablation of graphite, heat transfer at high velocities, heat transfer in rarefied gases, transpiration and film cooling**.**	6

TEXT BOOKS

1. Gilmore, D.G; "Spacecraft Thermal Control Handbook, Volume I: Fundamental Technologies"; TheAerospace Press, American Institute of Aeronautics and Astronautics; 2nd edition, 2002.
2. Michael J. Rycroft; "Spacecraft Thermal Protection Systems"; John Wiley & Sons; 2nd edition, 2019
3. Yunus A. Cengel and Michael A. Boles; "Fundamentals of Heat Transfer"; McGraw-Hill Education; 9th edition, 2021

REFERENCE BOOKS

1. Fortescue, P., Swinerd, G., and Stark, J; "Spacecraft Systems Engineering"; John Wiley & Sons; 4th edition, 2011
2. Mayer, R.X; "Elements of Space Technology for Aerospace Engineers"; Academic Press; 1st edition 1999
3. Eric A. Silk; "Spacecraft Thermal Design"; Cambridge University Press; 1st edition, 2020

6AR5-12: Civil Aviation Requirements - II

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To make the students familiarize with Regulatory Framework:
2. To familiarize students with CAR-66, CAR-145 & CAR-145.
3. To impart knowledge on Aircraft Certification.
4. To acquaint students' knowledge with Applicable National and International Requirements.
5. To make the students learn Continuing Airworthiness.
6. To acquire knowledge on Safety Management System.

Course Outcomes

Students will be able to

1. Interpret the Regulatory Framework.
2. Illustrate the importance of CAR-66, CAR-145 & CAR-145.
3. Explain the Procedure of Aircraft Certification.
4. Compare the features of National and International Requirements.
5. Describe the Continuing Airworthiness in an aircraft.
6. Identify the various Safety Management System and its operation in an aircraft.

S. No	Contents	Hours
1	**Introduction:** Role of International Civil Aviation Organization, The Aircraft Act and Rules made there under, Role of the DGCA, The Aircraft Rules (Applicable to Aircraft Maintenance and Release) Aeronautical Information Circulars (Applicable to Aircraft Maintenance and Release) CAR Sections 1 and 2	6
2	**Series-B:** Minimum equipments, instruments required for various types of operation. **Series M** Modification, concession, Airworthiness Directive, Service Bulletins. Approval oforganization, Documents required to be carried on board, Issue of type approval, Registration markings.	6
3	**CAR 145:** Approval of Maintenance Organisations: Terms of approval, Facility requirements, Personnel requirements, Certifying staff and support staff,Maintenance procedures and quality system, Maintenance organization exposition, Privileges and changes to the organization.	5
4	**CAR 21:** Certification procedures for aircraft and related products and parts: General provisions, Production without production organization approval, Noise certificates, Repairs and Indian technical standard order authorizations, Identification of products, parts and appliances.	7

	Continuing airworthiness requirements :Acceptable means, Airworthiness review certificate. **CAR-66.** Detailed understanding of CAR-66, CAR-145 and CAR M Subpart F, Relationship between CAR-21, CAR-M, CAR-145, CAR-66, CAR 147.	
5	**Human Factor:** Human performance and limitations relevant to the duties of an aircraft maintenance engineer licence holder, social psychology, Factors affecting performance physical environment, tasks, communication, human error, hazards in a workplace	4

TEXT BOOKS

1. Civil Airworthiness Requirements (www.dgca.nic.in), 2016.
2. Civil Aircraft Airworthiness Information and Procedures (CAP 562).
3. Civil Aviation Requirements Section 2 - Airworthiness.

REFERENCE BOOKS

1. Gran E L and Richard Levenworth; "Statistical Quality Control"; McGraw Hill; 7th Edition 1997
2. Manual of Civil Aviation/ Organisation Manual DGCA, 2017.
3. The Indian Aircraft Act and the Rules(www.dgca.nic.in),2008
4. Ian H. Brown; "Air Law and the ICAO"; 5th edition, 2016
5. Andrew J. Thomas; "Principles of Air Law"; 11th edition, 2021

6AR5-13: Aircraft Instrumentation and Control Engineering

Credit: 2Max **Marks: 100(IA: 30, ETE: 70)**

2L+0T+0P **End Term Exam: 3 Hours**

Course Objectives

1. To impart the knowledge about different types of Instruments and control systems
2. To provide the basics of measurements and different parameters
3. To learn the applications of these fundamental measurement systems.
4. To introduce the mathematical modeling of systems, open loop and closed loop systems and analyses in time domain and frequency domain.
5. To impart the knowledge on the concept of stability and various methods to analyze stability in both time and frequency domain.
6. To compute guidance commands with the knowledge of the guidance laws.

Course Outcomes

Students will be able to

1. Understand the basics of measurements and different parameters
2. Identify the applications of these fundamental measurement systems.
3. Select proper instrumentation requirements for aerospace vehicles
4. Ability to solve the Block diagram representation of control systems, Reduction of block diagrams, Signal flow graph and problems based on it.
5. Ability to apply mathematical knowledge to model the systems and analyse the frequency domain
6. Ability to check the stability of the both time and frequency domain

S. No	Contents	Hours
1	**Introduction:** Q meter, Vector Impedance meter, Measurement of RF Power frequency & Voltage. Introduction to shielding, grounding ,and interference. Theory and working principle of the galvanometer, Analog Voltmeter, ammeter and Multimeters, Digital Voltmeter	6
2	**Oscilloscopes, Signal Generation and Transducers :** CRT Construction, Basic CRO circuits, CRO Probes, Oscilloscope Techniques of Measurement of frequency, Phase Angle and Time Delay.	6
3	**Sine wave generators:** Frequency synthesized signal generators, Sweep frequency generators. Signal Analysis - Measurement Technique, Wave Analyzers, Frequency - selective wave analyser, Heterodyne wave analyser, Harmonic distortion analyzer, Spectrum analyzer., Construction, Working Principles.	5
4	**Control Systems Analysis and Components:** Open loop and close loop control systems. Block diagram algebra and transfer function. Differential equations, Determination of transfer function by block diagram reduction technique & signal flow graph method. Mason gain formula and calculation of transfer function.	5

5	**Time Domain Analysis Of First Order & Second Order Systems:** Transient and steady state response analysis. Steady state error & error constants. Effects of pole and zero addition on transient and steady state response. Absolute stability and relative stability. Routh's and Hurwitz criterion of stability. **Frequency Domain Analysis:** Root locus method of analysis, Bode plot, Design specification in frequency domain and gain and phase margin.	6

TEXT BOOKS

1. Thomas G. Beckwith, Roy D. Marangoni, and John H. Lienhard; "Mechanical Measurement"; Pearson Education; 6th edition 2013.
2. Jack P. Holman; "Experimental Methods"; McGraw-Hill Education; 8th edition, 2017.
3. Donald G. Fink; "Measurement and Instrumentation"; CRC Press; 9th edition, 2020.
4. Norman S. Nise; "Control Systems Engineering"; Pearson Education India; 8th edition, 2022.

REFERENCE BOOK

1. Ogata K; "Modern Control Systems"; Pearson Education India; 6th edition, 2019.
2. Gopal M; "Control Systems"; Tata McGraw-Hill Education; 8th edition, 2021.
3. James F. Franklin; "Instrumentation and Measurement"; CRC Press; 8th edition, 2017.
4. Nagoor Kanishka; "Control Systems: Theory and Applications"; McGraw Hill Education; 4th edition, 2020.

6AR4-20: Composite Materials Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To train the students on fabrication techniques of composites
2. To train the students on testing parameter of composites

Course Outcomes

Upon successful completion of the course, the students will be able to;

1. **CO1:** Learn about classification of composites
2. **CO2:** Fabricate of Glass Fiber/Carbon Fiber composite
3. **CO3:** Fabricate of Natural Fiber composite
4. **CO4:** Examine mechanical behaviour of natural fiber composite
5. **CO5:** Learn about 3-D printer
6. **CO6**: Learn about role of macro, micro and nano particle in composites.

S. No	Contents (Any ten experiments)	Hours
1	Study and classification of composites.	
2	Fabrication of Glass Fiber/Carbon Fiber using different matrix composite material by Hand layup/compression moulding method	
3	Fabrication of Natural Fiber Composite material by Hand layup method.	
4	Fabrication of Natural Fiber Composite material by compression moulding method.	
5	Determination of Mechanical behavior of Fabricated Glass Fiber/Carbon Fiber using different matrix Composite material.	
6	Determination of Mechanical behavior of Natural Fiber Composite Material.	
7	Performance of Structural Flush repairing Technique in laminated structures of composites.	
8	Study about machine parameter of DLP 3-D printer.	
9	Study about role of macro, micro and nano particle in composites.	
10	Study about testing on composite materials	

6AR4-21: Aircraft Electrical System Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To Carry out Overhaul procedure including leak test of lead acid battery and Nickel Cadmium battery.
2. To study the Constructional details & testing of DC ,AC generators.

Course Outcomes

Upon successful completion of the course, the students will be able to;

1. **CO1:** Learn about the battery Overhaul procedure including leak test.
2. **CO2:** Operate and service of DC & AC generators.
3. **CO3:** Learn about the overhaul procedure of Carbon pile voltage regulator, correction of its, basic setting and adjustment making.
4. **CO4:** Operate and checking of input and output voltage adjustment of Frequency control in rotatory & Static Inverter.
5. **CO5:** Find out identification of cables and wires..

S. No	Contents (Any ten experiments)	Hours
1	(a). To carry out the condition of Lead-Acid battery & to adjustment of specific gravity of electrolyte. (b). To carry out lead acid battery charging practice by using constant voltage charger and constant current charger. (c). To carry out capacity test and insulation test on lead acid batteries. (d). To carry out how to learn safety precautions to be observed in lead acid battery charging room. (e). To carry out overhaul procedure including leak test of cell of lead acid battery.	
2	(a). To carry out check the condition of Nickel cadmium battery and to determine the state of charge. (b). To carry out cell balancing and charging of Nickel cadmium battery by constant current charger. (c). To carry out check the electrolyte test level and insulation test on Ni-Cd battery. (d). To carry out how to learn safety precautions to be observed in Nickel Cadmium battery charging room. (e). To carry out cell replacement in Nickel Cadmium battery. (f). To carry out deep cycling of Nickel Cadmium batteries.	
3	(a). To understand the constructional details of aircraft DC generator. (b). To carry out dismateling, examination and reassembly of DC generator.	
4	To carry out strip inspection and Mica under cutting of commutators and to check for brush wear, brush spring loading and brush bedding.	
5	(a). To carry out testing of DC generator elements. (b). To carry out armature testing. (c). To carry out continuety test on field coils, armature shaft alignment and wear of ball races and housing.	

6	To carry out reassembly and Insulation test of a DC Generator.	
7	(a). To carry out the testing of Generator on test rig. (b). To carry out the testing of Alternator on test rig.	
8	(a). Startor motor for piston and turbine aero engine, dismantling, examination for condition and wear. (b). To carry out the check for brush gear & commutator of startor motor for piston and turbine aero engine. (c). To carry out the check for clutches and gear drive, reassembly of startor motor.	
9	Dismantling, Inspection, reassembly & test of motors for fuel line pumps and wind screen wipers.	
10	(a). To carry out dismantling, examination for condition and wear, reassembly of linear rotatory actuators. (b). To carry out , bench testing of linear rotatory actuators.	
11	To carry out constructional details of alternator.	
12	(a). To carry out dismantling, examination, & reassembly of AC generator. (b). To carry out test on AC generator.	
13	(a). To carry out partial dismantling, examination and reassembly of carbon pile and other types of voltage regulator. (b). To carry out overhaul procedure of voltage regulator, correction of its basic setting and adjustment making.	
14	(a). To learn about identification of cables & wires. (b). To become familiar with plugs & sockets.	
15	Examination and practical overhaul of a wide range of miscelaneous electrical components such as transformer, transducer, magnetic amplifiers, rectifiers, wheat stone bridgeand other balancing devices & sensing elements.	
16	Adherence of all testing in accordance with manufactures instruction for electrical circuit equipments.	
17	To carry out constructional detail of transformer rectifier unit.	
18	(a). To carry out dismantling, examination and reassembly of convertors. (b). To carry out dismantling, examination and reassembly of Invertors. (c). To carry out dismantling, examination and reassembly of Switch gear, Heating units. (d). To carry out dismantling, examination and reassembly of Actuators.	
19	To carry out testing and checking of input and output voltage adjustment of frequency control in rotatory invertor.	
20	(a). To carry out inspection of Static Invertor, adjustment & testing of output voltage & frequency. (b). To carry out dismantling, examination & reassembly of cutout, solenoids & relay from various circuits & thermal circuit breakers, reverse current relays	

6AR4-22: Aircraft Instrument System Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To train the students on pitot-static instruments
2. To train the students on functional test on various indicator in aircraft.

Course Outcomes

Upon successful completion of the course, the students will be able to;

1. **CO1:** Operate pneumatic system pitot static system of aircraft.
2. **CO2:** Carry out servicing of different types of pressure gauges, altimeter, air speed indicator, vertical speed indicator etc.
3. **CO3:** Carry out calibration check of different types of pressure gauges, altimeter, air speed indicator, vertical speed indicator etc.
4. **CO4:** Carry out servicing of different components of pitot static system, vacuum operated systems.
5. **CO5:** Carry out the functional test on various system like flap position indicator rudder position indicator, fuel quantity indicator, fuel flow system, flight data recording system, and other systems.
6. **CO6:** Acquaint with the constructional details and operation of angle of attack indicator.

S. No	Contents (Any ten experiments)	Hours
1	To dismantle a mechanical type pressure gauge, carry out inspection of various component and reassemble it after inspection.	
2	To calibrate the mechanically operated pressure gauge with the help of dead weight tester.	
3	To carry out maintenance check of Pitot-head and static vents and to carry out leak test of pitot-static system of aircraft.	
4	To dismantle an altimeter and carry out inspection of its various component and the reassemble it.	
5	To carry out demonstration of calibration check of altimeter.	
6	To get acquaint with partial dismantling, parts inspection and reassembling of air speed indicator.	
7	To get acquaint with the procedure of case leak check and calibration of Air Speed Indicator.	
8	To demonstrate the procedure of dismantling, inspection and reassembling of vertical speed indicator.	
9	To get acquaint with the calibration procedure of vertical speed indicator.	
10	To get acquaint with the constructional details and operation of thermocouple and exhaust gas temperature indicator.	
11	To get acquaint with the constructional details and operation of tacho-generatior and RPM indicator.	
12	To get acquaint with the constructional details and operation of fuel quantity transmitter and indicator.	
13	To get acquaint with the constructional details and operation of fuel flow transmitter and indicator.	
14	To get acquaint with the constructional details and operation of flight control position transmitter and indicator.	
15	To get acquaint with the constructional details and operation of angle of attack indicator.	

6AR4-23: Aircraft Radio Navigation Lab

Credit: 1Max **Marks: 100(IA: 60, ETE: 40)**

0L+0T+2P

Course Objectives

1. To test impedance of HF, UHF and microwave antenna.
2. To check the functioning of ELT unit by pressing the test switch.
3. To examine the sensitivity of VOR and ILS TR unit
4. To test the sensitivity and operation of ATC transponder.

Course Outcomes

Upon successful completion of the course, the students will be able to;

1. **CO1:** Perform the operation of CRO and signal generator and inspect static dischargers
2. **CO2:** Carry out installation and servicing of aerial mast.
3. **CO3:** Carry out calibration check of current, voltage and resistance with the help of AVO meter/ Multimeter
4. **CO4:** Trace out sinusoidal wave, triangular wave and square wave.
5. **CO5:** Demonstrate ILS, DME and VOR system, its various sub assemblies, connections and power supplies
6. **CO6:** Acquaint with the constructional details and operation of ELT and ATC transponder.

S. No	Contents (Any ten experiments)	Hours
1	To perform the operation of CRO and signal generator	
2	To carry out inspection and servicing of static dischargers.	
3	To carry out installation and servicing of aerial mast.	
4	To check current, voltage and resistance with the help of AVO meter/ Multimeter	
5	To trace out sinusoidal wave, triangular wave and square wave.	
6	To find out the phase, voltage and frequency of sinusoidal wave, triangular wave and square wave.	
7	To demonstrate ILS and VOR system, its various sub assemblies, connections and power supplies	
8	To demonstrate DME system, its various sub assemblies, connections and power supplies	
9	Testing of matching of impedance of HF, UHF and microwave Antenna.	
10	Checking the functioning of ELT unit by pressing the test switch on and observing for illumination of test light for continuity.	
11	Testing of sensitivity and operation of ATC transponder in mode A, C and S during ramp testing.	