Syllabus of

UNDERGRADUATE DEGREE COURSE

B.Tech. V Semester

Aeronautical Engineering

Rajasthan Technical University, Kota

Effective from session: 2019-20

5AN3-01: Vibration Engineering

Credit: 2 **Max. Marks: 100 (IA: 20, ETE: 80)**
2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Single Degree of Freedom Systems:** Introduction to simple harmonic motion, D'Alembert's principle, free vibrations, damped vibrations, forced vibrations, with and without damping, support excitation, transmissibility, vibration measuring instruments.	6
3	**Multi Degree of Freedom Systems:** Two degrees of freedom systems, static and dynamic couplings, vibration absorber, Multi degree of freedom systems, principal co-ordinates, principal modes and orthogonal conditions, Eigen value problems, Hamilton's principle, Lagrangean equations and application.	6
4	**Continuous Systems:** Vibration of elastic bodies, vibration of strings, longitudinal, lateral and torsional vibrations.	4
5	**Approximate Methods:** Approximate methods, Rayleigh's method, Dunkerley's method, Rayleigh-Ritz method, matrix iteration method.	4
6	**Elements of 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.	5
	TOTAL	26

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5AN4-02: Aerodynamics-II

Credit: 3 **Max. Marks: 150 (IA: 30, ETE: 120)**

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

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Basic Concepts:** 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
3	**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
4	**Normal Shocks:** Normal shock, normal shock relations for perfect gas, Prandtl relation, Rankine-Hugoniot equation; Moving normal shock.	6
5	**Oblique Shocks:** Oblique shock relations, strong and weak shock solutions, shock polar and detached shock.	6
6	**Expansion Waves:** Expansion fan, Prandtl-Meyer function, and Applications of expansion waves.	4
7	**Non-Isentropic 1d Flow:** Rayleigh flow (flow with heat addition), Fanno flow (flow with friction).	4
8	**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
9	**Experiments in Compressible Flow:** Transonic, supersonic and hypersonic tunnels and their peculiarities, Blow down, in draft and continuous wind tunnels, Shock tubes, Pressure measurement, Velocity measurement, Optical methods of flow visualization.	5
	TOTAL	40

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5AN4-03: Aircraft Structures-II

Credit: 3 **Max. Marks: 150 (IA: 30, ETE: 120)**

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

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
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.	8
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 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 strength-sheet stiffener panels-Effective width. Thermal post buckling of aircraft wing.	8
6	**Stress Analysis in Wing And Fuselage:** Shear resistant web beams-Tension field web beams(Wagner's), Shear and bending moment distribution for cantilever and semi-cantilever types of beams, Loads on aircraft, lift distribution, V-n diagram, Gust loads.	8
	TOTAL	40

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5AN4-04: Propulsion-I

Credit: 3 **Max. Marks: 150 (IA: 30, ETE: 120)**

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

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Aircraft Piston Engines**: Working of the internal combustion engine and basic engine components, revision of engine terminologies. SI and CI engines, 4 stroke and 2 stroke engines, various types of arrangements for multi cylinder aircraft engines-firing order- valve timing diagrams	5
3	**Engine Performance Parameters:** IP, BP and FP, mean effective pressure, SFC, compression ratio; engine efficiencies, torque and power calculation based problems. Factors affecting engine power. Super charging, types of super chargers; and associated cycles to piston engine, numerical. Lubrication system, Fuel metering system, ignition system, noise and emission control.	8
4	**Propeller Fundamentals and Construction:** Fundamentals, Blade element theory, High/low blade angle, reverse angle, angle of attack, rotational speed; Propeller slip, Aerodynamic, centrifugal, and thrust forces, Torque, Relative airflow on blade angle of attack, Vibration and resonance. Construction methods and materials used. Blade station, blade face, blade shank, and blade back and hub assembly, Fixed pitch, controllable pitch, constant speeding propeller, Propeller/spinner installation.	8
5	**Propeller Pitch Control and Synchronising:** Speed control and pitch change methods, mechanical and electrical/electronic, Feathering and reverse pitch, Overspeed protection. Synchronising and synchrophasing equipment	6
6	**Propeller Maintenance:** Static and dynamic balancing, Blade tracking, Assessment of blade damage, erosion, corrosion, impact damage, delamination, Propeller treatment/repair schemes, Propeller engine running. Fluid and electrical de-icing equipment, Propeller preservation and depreservation	6
7	**Introduction to Gas Turbine Engines:** Newton's laws of motion; Constructional arrangement and operation of turbojet, turbofan, turbo shaft, turboprop, ramjet, scramjet. Relative merits and demerits. Two and three spool arrangements, factors affecting thrust, methods of thrust augmentation, performance parameters of jet engines.	6
	TOTAL	40

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5AN4-05: Aircraft Systems

Credit: 3 **Max. Marks: 150 (IA: 30, ETE: 120)**

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

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Airplane Control Systems:** Conventional Systems, Power assisted and fully powered flight controls, Power actuated systems, Engine control systems, Push pull rod system, flexible push pull rod system, Components, Modern control systems, Digital fly by wire systems, Auto pilot system active control Technology,	6
3	**Aircraft Communication and Navigation Systems:** Introduction to Communication and Navigation systems, Instrument landing systems, VOR - CCV case studies.	3
4	**Hydraulic & Pneumatic Systems:** Hydraulic systems, Study of typical workable system, components, Hydraulic system controllers, Modes of operation, Pneumatic systems, Advantages, Working principles, Typical Air pressure system, Brake system, Typical Pneumatic power system, Components,	6
5	**Landing Gear Systems:** Landing Gear systems, Classification, Shock absorbers, Retractive mechanism. Anti skid system, wheels and brake, steering systems, indications.	3
6	**Fuel Systems:** Types of fuels, their properties and testing, color codes, fuel requirements, pumps, fuel transfer systems, fuel tanks, plumbing, valves, indications and warnings.	6
7	**Auxiliary System:** Various types systems, components and operation of air-conditioning System, Pressurization System, Oxygen Systems, Fire Protection Systems, Deicing and Anti Icing systems, Seat Safety System: Ejection seats, survival packs, parachutes, pilots's personal equipment, life rafts, doors, windows, emergency exits and seat belts.	7
8	**General 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.	8
	TOTAL	40

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5AN5-11: Space Dynamics

Credit: 2 **Max. Marks: 100 (IA: 20, ETE: 80)**

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

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**General:** 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 spacecraft, spacecraft subsystems; Newton's law of gravitation, Kepler's laws; Vector differentiation, kinematics relative to moving frames	6
3	**Two-Body Problem:** Equation of relative motion, conservation of angular momentum and energy; Different types of trajectories, orbital elements.	6
4	**Orbital Manoeuvres:** Hohmann transfer, Bielliptic transfer, plane change manoeuvres, combined manoeuvres, low thrust transfer manoeuvres, Non-coplanar transfer, Rendezvous missions, interplanetary trajectories, gravity assist trajectories; Orbit perturbations	5
5	**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, rocket thrust vector control methods, Concept of multi-staging, series and parallel staging configurations, optimal staging solutions, Re-entry vehicles and missions, aero braking.	8
	TOTAL	26

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5AN5-12: Aircraft Maintenance Practices

Credit: 2 **Max. Marks: 100 (IA: 20, ETE: 80)**

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

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**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.	3
3	**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
4	**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
5	**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
6	**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
7	**Maintenance Procedures** Maintenance planning, Modification procedures, Stores procedures, Certification/release procedures, Interface with aircraft operation, Maintenance Inspection/Quality Control/Quality Assurance, Additional maintenance procedures. Control of life limited components	4
	TOTAL	26

5AN5-13: Fatigue and Fracture

Credit: 2 **Max. Marks: 100 (IA: 20, ETE: 80)**
2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
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's approximation, plastic zone size, Dugdaale model, determination of J integral and its relation to crack opening displacement.	6
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.	5
6	**Detection of Cracks:** NDT methods. Experimental determination of GIC, KIC, J-Integral and CTOD.	4
	TOTAL	26

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5AN4-21: Aircraft System Lab

Credit: 1 **Max. Marks: 50 (IA:30, ETE:20)**

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

SN	Contents
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

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5AN4-22: Aircraft Structures Lab

Credit: 1 **Max. Marks: 50 (IA:30, ETE:20)**
0L+0T+2P **End Term Exam: 2 Hours**

SN	Contents
1	Determination of Young's modulus of aluminum using electrical extensometers
2	Determination of fracture strength and fracture pattern of ductile & brittle materials.
3	Deflection of beams with various end conditions for different load.
4	Verification of Maxwell's Reciprocal theorem & principle of superposition.
5	Compression tests on long and short columns, Critical buckling loads, South well plot.
6	Wagner beam-Tension field beam.
7	Shear centre location for open sections.
8	Shear centre location for closed sections.
9	Flexibility matrix for cantilever beam.
10	Beam with combined loading.
11	Experiment on Photo- elastic bench

5AN4-23: Aircraft Maintenance Practice Lab

Credit: 1 **Max. Marks: 50 (IA:30, ETE:20)**
0L+0T+2P **End Term Exam: 2 Hours**

SN	Contents
1	Inspection of Aircraft component by all the three NDT methods a. Oil and chalk method b. Dye Penetrant and Flourescent method c. Magnetic flaw detection
2	Bending of sheet metal with a high degree of accuracy, layout fastener and install solid rivets in accordance with the any structure of an aircraft.
3	Aircraft Material Bonding by a)Welding, b) Brazing, c) Soldering
4	Removal & Installation of an pressure gauge, heat exchanger and EMDP of hydraulic system
5	Removal, servicing& Installation of yaw damper and mach trim
6	Removal & installation of Landing Gear down lock pins, inspection of Landing Gear
7	Remove, install and inspect the aircraft pneumatic braking system. Pneumatic system and its components such as electricity powered compressor, power cylinders, air motors and other pneumatic devices should be removed, inspected, installed and functional test.
8	Remove, Install and Inspect the Aircraft Line Replacement Unit (LRU) Mechanical. In this the Replacement of main landing gear wheel should be done as per the aircraft maintenance manual.

5AN4-24: Aircraft / Aerospace Disaster Management.

Credit: 1 **Max. Marks: 50 (IA:30, ETE:20)**
0L+0T+2P **End Term Exam: 2 Hours**

SN	Contents
1	Basic Disaster Management Aspects.
2	Long-Term Measures of Aircraft / Aerospace Disaster Management.
3	Major Factors Prior to Disaster Impact.
4	Response to Disaster Impact.
5	Major Post-Impact Factors.
6	Disaster Management Support Requirements.
7	Each student should perform a case study of a aircraft/ aerospace disaster and submit a summary report.

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Syllabus of

UNDERGRADUATE DEGREE COURSE

B.Tech. VI Semester

Aeronautical Engineering

Rajasthan Technical University, Kota

Effective from session: 2019-20

6AN3-01: Mechanics of Composite Materials

Credit: 2 **Max. Marks: 100 (IA: 20, ETE: 80)**
2L+0T+0P **End Term Exam: 3 Hours**

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Basics of Composites:** 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
3	**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
4	**Elastic Behaviour of Composite Lamina-Micromechanics:** Volume fraction, weight fraction, density of composites, Micromechanics and acromechanics approach, Longitudinal elastic properties, transverse elastic properties, in-plane shear modulus, Poisson's ratio, Halpin-Tsai equations. Elastic Behaviour of Composite Lamina-Macromechanics, Stress- Strain relations of different material projection in Composite materials.	6
5	**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
6	**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	5
	TOTAL	28

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RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

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

6AN4-02: Propulsion – II

Credit: 4 **Max. Marks: 200 (IA: 40, ETE: 160)**

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

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Jet Engine Intakes and Exhaust Nozzles:** The basic steady 1-D gas dynamics flows design and operating characteristics, Inlet, design, sizing and performance for various flow regimes, Ram effect, Internal flow and Stall in subsonic inlets, relation between minimum area ratio and eternal deceleration ratio, diffuser performance, modes of operation, supersonic inlets, starting problem on supersonic inlets, shock swallowing by area variation, real flow through nozzles and nozzle efficiency, losses in nozzles, ejector and variable area nozzles, interaction of nozzle flow with adjacent surfaces, thrust reversal.	6
3	**Jet Engine Combustion Chambers:** Chemistry of combustion, Combustion equations, Combustion process, classification of combustion chambers, combustion chamber performance, effect of operating variables on performance, flame stabilization, Cooling process, Materials, Aircraft fuels, HHV, LHV.	7
4	**Jet Engine Compressors:** Euler's turbo machinery equation, Principle operation of centrifugal compressor, Principle operation of axial flow compressor, Work done and pressure rise, velocity diagrams, degree of reaction, free vortex and constant reaction designs of axial flow compressor, performance parameters axial flow compressors, stage efficiency.	5
5	**Jet Engine Turbines:** Principle of operation of axial flow turbines– limitations of radial flow turbines, Work done and pressure rise, Velocity diagrams, degree of reaction, constant nozzle angle designs, performance parameters of axial flow turbine, turbine blade cooling methods – stage efficiency calculations, basic blade profile design considerations, matching of compressor and turbine	6
6	**Ramjet and Scramjet Propulsion:** Operating principle of Ramjet and Scramjet engine, combustion in Ramjet and Scramjet engine, Ramjet and Scramjet performance and sample Ramjet and Scramjet calculations, problems associated with supersonic combustion, engine/airframe integration aspects of hypersonic vehicles, various types scramjet combustors, fuel injection schemes in scramjet combustors.	6
7	**Chemical Rocket Propulsion:** Operating principle, specific impulse of a rocket, performance characteristics of rockets, simple rocket design problems, types of igniters, Rocket nozzle classification, preliminary concepts in nozzle-less propulsion, air augmented rockets, pulse rocket motors, static testing of rockets & instrumentation, safety considerations	6

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8	**Solid and Liquid Propellant Rockets:** Selection criteria of solid and liquid propellants, Important hardware components of solid rockets, Propellant grain design considerations. Performance characteristic of Solid and Liquid Propellant Rockets, comparative study of solid and liquid propellant rocket. Advanced propulsion systems types, performance and applications.	**5**
	TOTAL	**42**

6AN4-03: Aircraft Stability and Control

Credit: 3 **Max. Marks: 150 (IA: 30, ETE: 120)**

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

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**General** 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 andcontrol.	3
3	**Longitudinal Stability Stick Fixed:** Basic equations of equilibrium, Stability criterion, Wing and tailmoments, 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
4	**Longitudinal Stability Stick Free:** Hinge moment coefficients, Stick free neutral point symmetricmaneuvers, stick force gradients and stick force per g. Aerodynamicbalancing of control surfaces.	5
5	**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
6	**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
7	**Lateral Static Stability and Control:** Effect of wing location, sweep and dihedral, fuselage and vertical tail, Couplingbetween rolling and yawing moments; Adverse yaw effects, Aileron reversal. Lateral control power, Roll damping, directional divergence.	5
8	**Dynamic Stability and Control:** Euler angles, Equations of motion, stability & control derivatives. Decoupling oflongitudinal and lateral-directional dynamics, Longitudinal modes, Lateral-directional modes, Phugoid, Autorotation and spin, Control response, impulse and step response.	6
9	**Aerodynamic Balancing:** The set-back rings, the horn balance, the aileron, the sealed nose balance andthe geared balance tab.	3
	TOTAL	40

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6AN4-04: Aircraft Performance

Credit: 3 **Max. Marks: 150 (IA: 30, ETE: 120)**

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

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Atmosphere:** Need to define standard atmosphere; International Standard Atmosphere, Stability of Atmosphere, Equivalent, calibratedand indicated airspeed, Primary flight instruments, ASI, VSI, turn-bank indicator.	3
3	**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, Variation of thrust, power and SFC with velocity and altitudes for air-breathing engines	6
4	**Steady Level Flight:** Equations of motion, Thrust and power required for level unaccelerated flight, Maximum thrust andpower 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 andendurance of jet and propeller engine airplanes, Condition for maximum range and endurance, effect of altitude, weight and wind	6
5	**Climbing Flight:** Unaccelearated 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.	5
6	**Gliding Flight:** Steady descent, equilibrium glide angle, equilibrium glide velocity, Minimum rate of sink and shallowestangle of glide, maximum gliding range, Glide hodograph.	5
7	**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 takeoffsystem, spoilers.	5
8	**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 and pull-down manoeuvres.	5
9	**High Lift devices:** Different types of trailing edge flaps, leading edge devices, boundary layer control, powered lift.	4
	TOTAL	40

6AN4-05: Avionics-I

Credit: 3 **Max. Marks: 150 (IA: 30, ETE: 120)**

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

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**General:** Basic of the application and identification of electrical cables used in Aircraft radio installation, crimping and soldering techniques, bonding continuity and insulation tests. Composition, performance (stability and tolerance) and limitations of the fixed resistors and varistors (carbon composition, carbon film, wire wound and metallic film). Basic of EMI (electromagnetic interference) and EMC (electromagnetic computability). Different types of interference caused by electrical and ignition system to radio apparatus, methods of minimizing or suppressing such interference, bonding and screening.	4
3	**Radar Engineering**: Radar definition, Radar range equation, pulsed, CW and Doppler Radars, MTI, Noise Figure consideration, various types of radar displays, Detection of radar signals in Noise.	3
4	**Microwave Engineering**: Various types of radar transmission Lines, Rectangular and circular waveguides, coaxial lines, field patterns modes (high order and evanescent), passive components (e.g., Directional couplers, filters, isolators and circulators), Device: Magnetron, Klystron, backward wave oscillator, Travelling wave tubes, Amplifiers and parametric amplifiers. Diode detectors and mixers	4
5	**Aerials and Propagation**: Antenna theory, various types of antenna for medium wave short wave, VHF frequencies, propagation at microwave frequencies, atmospheric attenuation, effects of precipitation, reflection, the voltage and current distribution along antenna of various length; characteristics of ground planes. Refraction and Diffraction phenomenon, clutter signals.	4
6	**Electronic Navigation:** Map and charts, classification of various navigation systems, celestial and radio navigation, Radio direction finding at medium, high and very high frequencies. The radio compass and Automatic Direction finders. Hyperbolic navigation systems, LORAN and Decca. TACAN. Aids to approach and landing, the standards ILS, various categories of ILS accuracy, MLS, Ground Control Approach Systems. Dead reckoning navigation systems, Doppler navigational and inertial navigation, global Positioning system(GPS), Alerts and collision Avoidance System(TCAS).	6
7	**Communication Equipment's:** Very high frequency (VHF) and high frequency (HF) airborne communications; frequency bands allocation; the methods of propagation and the ranges expected, both day and night; calculation of approximate range of communication (line of sight) with given data. Theory of operation, performance level and specifications of an Audio Integration System.	4

8	**Working Principle of Following Systems:** Very high frequency (VHF) communication system., Audio integration system (AIS), Emergency locator transmitters (ELT), Cockpit voice recorder (CVR), Very high frequency omnidirectional range (VOR), Automatic direction finding (ADF), Distance measuring equipment (DME), Very low frequency and hyperbolic navigation (VLF/OMEGA), Doppler navigation, global navigation, Satellite system, Air traffic control transponder, secondary surveillance radar, Weather avoidance radar, Radio altimeter, ARINC communication and reporting, Electronic emergency equipment requirements, Cabin entertainment equipment, IFR (Identification friends or FOE)	**6**
9	**Navigation Systems:** INS components: transfer function and errors, The earth in inertial space, the Coriolis effect, Mechanization. Platform and strap down, INS system block diagram, Different co-ordinate systems, Schuler loop, compensation errors, Cross coupling, Gimbal lock, Alignment.	**4**
10	**GPS Systems** Introduction to GPS system description, basic principles, position and velocity determination, Signal structure, DGPS, Estimation and mixed mode navigation, Integration of GPS and INS utilization of navigation systems in aircraft.	**4**
	TOTAL	**40**

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6AN5-11: Heat Transfer In Space Application.

Credit: 2 **Max. Marks: 100 (IA: 20, ETE: 80)**

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

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Space Craft Thermal Environments:** Launch and ascent environments, environment of earth orbit, environments of interplanetary missions.	4
3	**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
4	**Phase Change Materials :** When to use a PCM, PCM design. Heat Pipes, Types, Analysis, Testing, heat pipe applications and performances.	6
5	**Thermal Contact Resistance and Its Calculation:** Parameters influencing thermal joint resistance, effect of oxidation and interstitial effects.	5
6	**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
	TOTAL	28

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6AN5-12: Aircraft Rules and Regulation.

Credit: 2 **Max. Marks: 100 (IA: 20, ETE: 80)**

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

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Regulatory Framework:** 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	4
3	**CAR-66, CAR-145 & CAR-145** Detailed understanding of CAR-66, CAR-145 and CAR M Subpart F, Relationship between CAR-21, CAR-M, CAR-145, CAR-66, CAR 147.	6
4	**Aircraft Certification:** (a) General: Certification rules,Type Certification, Supplemental Type Certification, CAR-21, Aircraft Modifications and repairs approval and certification, Permit to fly requirements, Certificate of Airworthiness, Certificate of Registration, Noise Certificate, Weight Schedule, Radio Station Licence and Approval.	5
5	**Applicable National and International Requirements:** Maintenance Programme, Maintenance checks and inspections, Master Minimum Equipment Lists, Minimum Equipment, List, Dispatch Deviation Lists, Airworthiness Directives, Service Bulletins, manufacturers service information, Modifications and repairs, Maintenance, Maintenance manuals, structural repair manual, illustrated parts catalogue.	4
6	**Continuing Airworthiness:** Test flights, ETOPS /EDTO , maintenance and dispatch requirements, RVSM, maintenance and dispatch requirements, RNP, MNPS Operations, All Weather Operations.	4
7	**Safety Management System:** State Safety Programme, Basic Safety Concepts, Hazards & Safety Risks, SMS Operation, SMS Safety performance, Safety Assurance. Fuel Tank safety, Special Federal Aviation Regulations (SFARs) from 14 CFR SFAR 88 of the FAA and of JAA TGL 47, Concept of CDCCL, Airworthiness Limitations Items (ALI).	4
	TOTAL	28

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6AN5-13: Wind Tunnel Techniques

Credit: 2 **Max. Marks: 100 (IA: 20, ETE: 80)**

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

SN	CONTENTS	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Low Speed Wind Tunnels:** Classification, non-dimensional numbers, types of similarities, Layout of open circuit and closed circuit subsonic wind tunnels, design parameters-energy ratio, HP calculations, Calibration methods.	5
3	**High Speed Wind Tunnels:** Blow down, in draft and induction tunnel layouts and their design features, Transonic, and supersonic tunnels, peculiar features of these tunnels and operational difficulties, sample design calculations and calibration methods.	5
4	**Special Wind Tunnel Techniques:** Types of Special Wind Tunnels, Hypersonic, Gun and Shock Tunnels, Design features and calibration methods, Intake tests, store carriage and separation tests, wind tunnel model design for these tests	5
5	**Wind Tunnel Instrumentation:** Instrumentation and sensors required for both steady and unsteady measurements, Force measurements using three component and six component balances, calibration of measuring instruments, error estimation and uncertainty analysis.	6
6	**Flow Visualization and Non-Intrusive Flow Diagnostics:** Smoke and Tuft grid techniques, Dye injection special techniques, Oil flow visualization and PSP techniques, Optical methods of flow visualization, PIV and Laser Doppler techniques, Image processing and data deduction.	6
	TOTAL	28

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6AN4-21: Propulsion Lab.

Credit: 1.5 **Max. Marks: 75 (IA:45, ETE:30)**
0L+0T+3P **End Term Exam: 3 Hours**

SN	Contents
1	Study of an aircraft piston engine (Includes study of assembly of sub Systems, Various components, their functions and operating principles).
2	Calculate the cylinder area, sweep area and compression ratio.
3	Test the engine on piston engine test rig to determine: A) Specific fuel consumption B) Break horse power C) Indicated horse power D) Break thermal efficiency E) Mechanical efficiency F) Heat balance sheet G) Air consumption H) Volumetric efficiency for four stroke petrol engine.
4	Study of an aircraft jet engine - assembly of sub systems
5	Study of an aircraft jet engine - various components, their functions and operating principles
6	To study the functioning of aircraft gas turbine engines.
7	Determination of heat of combustion of Aviation fuel.
8	Performance testing and Pressure distribution of Nozzles.

6AN4-22:Composite Material Lab.

Credit: 1.5
0L+0T+3P

Max. Marks: 75 (IA:45, ETE:30)
End Term Exam: 3 Hours

SN	Contents
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/compression moulding method.
4	Determination of Mechanical behavior of Fabricated Glass Fiber/Carbon Fiber using different matrix Composite material.
5	Determination of Mechanical behavior of Natural Fiber Composite Material.
6	Performance of Structural Flush repairing Technique in laminated structures of composites.

6AN4-23: Avionics-I lab.

Credit: 1.5 **Max. Marks: 75 (IA:45, ETE:30)**
0L+0T+3P **End Term Exam: 3 Hours**

SN	Contents
1	Testing of matching of impedance of HF, UHF and microwave antenna.
2	Observing the selcal operation by enunciator panel light and chime, checking recorded data of CVR by connecting playback head jack on control panel, while parking relay and break relay are closed.
3	Checking the functioning of ELT unit by pressing the test switch on and observing for illumination of test light for continuity.
4	Testing of sensitivity of VOR and ILS TR unit by observing the RMI and HIS indications during ramp testing.
5	Testing of sensitivity and operation of ADF by observing RMI indication during ramp testing.
6	Testing of sensitivity and operation of ATC transponder in mode A, C and S during ramp testing.

6AN4-24: Aero Modelling and Fabrication

Credit: 1.5 **Max. Marks: 75 (IA:45, ETE:30)**
0L+0T+3P **End Term Exam: 3 Hours**

SN	Contents
1	Design using software and fabrication of fixed-wing gliders.
2	Comparison of properties of thermocole, balsa wood, Styrofoam, composites for aero model fabrication.
3	Detailed design of fixed-wing powered aero models.
4	Design, fabrication and testing of different components
5	Aerodynamic and structural design and analysis of any components of an Aircraft using any software.
6	Case study about the Use of flight simulator
7	Study of Concepts used in unconventional UAVs such as rotary wing models and ornithopters