AERONAUTICAL ENGINEERING

Total Markks:100

1. BASIC AERODYNAMICS AND AIRCRAFT MATERIALS

BASIC AERODYNAMICS: 07 Marks

The atmosphere, Fluid pressure, Standard atmosphere, International Standard Atmosphere (ISA), Temperature, Measurement of temperature, Conversion factors for units commonly used in various countries, Pressure, Pressure altitude, Effect of pressure, temperature and humidity on density, Density altitude, ICAO Standard atmosphere, Standard atmosphere as per ISA(International standard atmosphere), Behaviour of air, Speed of sound, Dynamic pressure, static pressure and total pressure Terms and difference between the three pressures, Explanation of total pressure in terms of dynamic and static pressure, air speed terminology in use and their meaning, Venturi tube, Theory of lift, The circulation theory of lift, Low speed aerofoil, Aerofoil terminology, Types of aerofoils. Factors affecting the performance of aerofoils. General theory of generation of lift in a wing, Aspect ratio and stalling angle, Sweep back wings, Slats and flaps, Effect of compressibility on lift, effect of various speeds on coefficient of lift(CL), Transonic and Supersonic Aerodynamics, Shock waves.

AIRCRAFT MATERIALS: 05 Marks

Selection of materials, economic consideration, Availability, Cost, shaping equipment required. Engineering considerations- Strength, Weight, Corrosion, Aircraft materials and their properties- types of plain carbon steel, Steel numbering system-SAE (Society of Automobile Engineers). Nickel alloys, Aluminium alloys, Composite materials, Advantages of composites, Corrosion and corrosion prevention and its effects on aircraft structures, important factors which influence corrosion process.

2. AIRCRAFT INSTRUMENTS AND AIRCRAFT SYSTEMS

AIRCRAFT INSTRUMENTS: 05 Marks

Four important Instrument elements, Pressure measurement systems, two main categories of pressure measurements- direct reading and remote indication, Temperature measurement systems for aircraft - special requirements, range, Methods of temperature measurements, RPM measurement systems and its importance, Fuel measurement systems, importance of fuel measurement, Fuel contents gauge, Float arm gauge, capacitor type of gauge. Pitot system of aircraft-purpose and working principle. Altimeter - theory of operation, Pressure altitude and indicated altitude, 'Q' Codes and their purpose, Air Speed Indicator- purpose, Air speed terminology, Square law compensation for air speed indicator, Rate Of Climb/Decent Indicator(ROCI)- purpose, Various types of Metering unit and its purpose, Machmeter - purpose and need for machmeter, Gyroscope- its application in aircraft, properties, Three degrees of freedom, Gyroscopic references, Limitations of a free gyroscope, Artificial Horizon (AH)- introduction, Turn And Bank Indicator

(TBI)- its purpose, Aircraft Heading System- purpose, Direction Indicating/Radio Indicating Compass- DI/RI Compass, RMI front panel/display, Cabin Pressurisation-need for cabin pressurization, Standard practice of pressurization, CPCV, Aircraft Oxygen System- purpose, Types of aircraft oxygen system i.e. continuous flow type and demand type, Important components, L O X (liquid oxygen) System, Head Up Display, Head Down Display, Multi Function Display, Fly- By Wire Technology.

AIRCRAFT SYSTEMS: 07 Marks

Aircraft Flight Control Systems- Axes of Motion Vertical, Longitudinal and Lateral, Primary Control Surfaces, SECONDARY Control Surfaces, Tertiary Control Surfaces, Primary flight controls-Pitch, Roll, Yaw, Throttle, Secondary effects of controls: explain briefly, Main Control Surfaces, Trim tabs, Spoilers, Flaps, Slats, Air brakes and Classification of flight control systems (FCS), Aircraft Fuel Systems- Fuel system. Information system- Fuel contents, Fuel Pressure, Low/critical fuel level warning, Positive transfer of fuel from various tanks, Safety-Protection of the systems from hazards, refuelling, De-fuelling, Aircraft Remote Control Systems Media-Mechanical, Aircraft Remote Control Systems-Hydraulic Media, Hydraulic System, Remote Control System- Pneumatic Media, Aircraft Undercarriage Systems, Features of Nose Undercarriage, Steering system of an Aircraft-need and types of steering, Aircraft Environment System- Cabin pressurization and air conditioning systems, Altitude limits, Aircraft Emergency Systems, Aircraft fire warning systems-common causes, Purpose and function of fire detection system, Ice And Rain Protection Systems- Common flight hazards due to ice-pitot tubes, control systems etc, Areas sensitive for ice formation

3.AIRCRAFT STRUCTURES AND SOM

AIRCRAFT STRUCTURES: 07 Marks

Air Frame Design and Construction- Structural members, Major structural stresses, Plane truss and analysis of forces in the members, Fixed Wing Aircraft- Identification of aircraft structural components for fixed wing, single engine, propeller driven aircraft, Fuselage Of Aircraft- various sections of fuselage, Types Of Fuselage- Truss type, Monocoque, Semi-monocoque, . Wing Structures- three fundamental designs for wing structure - Mono spar, Multi spar, Box Beam, Wing Configurations- various wing configurations, Leading edge shapes, Trailing edge shapes, common forms of wings- Low, Dihedral and Delta wings, Spars And Ribs purpose, Basics Of Honey Comb Section Wings- Basics Of Nacelles/Pods, Cowlings- Cowlings, skin and fairing, Main Control Surfaces- purposes, Loads On Aircraft- Types of loads, design load, Helicopter Structures-Location of major helicopter components, Wooden Aircraft Structures- aircraft fabrics, doping and dopes, Aircraft Painting and Finishing – importance, Effect of proper finishing.

SOM 05 Marks

Simple stresses & strains viz. tensile, compressive, Shear, Crushing, Thermal stresses, & corresponding strains–Problems on Direct Stress & Linear Strain- Stress-,Hook’s

Law- Strain curve for Ductile material and Brittle material with all parameters.- factor of Safety. Elastic Constants - Lateral Strain ,Poisson's ratio, Bulk Modulus, Shear Modulus ,Volumetric Strain-Relation between elastic constants- Problems on elastic constants.

Definition - Shear Force and Bending Moment –Types of beams, types of load acting on beams ,Sagging & Hogging Bending Moment and its importance –sign convention to draw SFD and BMD- Concept of Maximum bending moment.
Centre of Gravity, Moment of Inertia & its Importance -Parallel & Perpendicular Axis Theorem-C.G of Rectangle, Triangle, Circle, Semi-circle, T-Section, I-Section, L-Section, Channel-Section. Introductionto Torsion , Angle of Twist Assumptions in theory of Torsion -Power Transmitted by a shaft, axle of solid and hollow sections subjected to Torsion - Comparison between Solid and Hollow Shafts subjected to pure torsion.

4. THERMODYNAMICS, PISTON ENGINE THEORY AND JET ENGINE THEORY

THERMODYNAMICS **05 Marks**

Basic concepts-Definitions :system - boundary, surrounding, working fluid and state of a system.-thermodynamic systems – closed, open and isolated systems Properties of system- Intensive and Extensive properties Definitions for properties like Enthalpy (H), Entropy(s) Internal energy (U)- Specific heat at constant pressure(C_p), specific heat at constant volume(C_v) for a gas-Relation between C_p & C_v , characteristic gas equation, Universal gas constant, Definitions for quasi-static work flow-Law of thermodynamics-Zeroth, first & second laws of thermodynamics-Steady flow energy equation

Thermodynamic processes- Explain with P-V and T-S diagram the Constant pressure, Constant volume, Isothermal, Isentropic, Polytrophic, Free expansion and throttling processes & equations representing the processes- Derivation for work done for the above processes- Calculation of change in internal energy, heat supplied or rejected, change in Entropy for the above processes. Thermodynamic cycles – reversible and irreversible cycles conditions for reversibility of a cycle-Explanation of Carnot cycle with P.V. and T-S diagrams, Air standard Efficiency.

PISTON ENGINE THEORY: **05 Marks**

Otto cycle, Difference between two and four stroke spark ignition engines. Purpose of reduction gear box, Engine power, engine rating and engine efficiency, Super charging, Fuel and carburetion, Induction, cooling and exhaust.

JET ENGINE THEORY: **07 Marks**

Basic theory of jet propulsion, Principle of operation of jet engine, Thrust and its equation. Classification of jet engines, Brayton cycle. Types of jet engines turbo prop,

turbojet, turbofan. Subsonic and supersonic inlet ducts. Centrifugal and Axial flow compressor, compressor stalling and surging. Types of combustion chambers. Impulse and reaction type turbine. Purpose and working of Thrust reversal. Purpose of Afterburner.

5. AVIONICS AND AIRCRAFT RADIO SYSTEMS ,AIRCRAFT ELECTRIAL SYSTEMS

AVIONICS AND AIRCRAFT RADIO SYSTEMS: 10 Marks

Radio Communication System Fundamentals – EM waves, medium of propagation, Radio and radar frequency spectrum, uses and limitation of R.F. bands. Radio wave propagation – ground wave, sky wave, radiation angle, skip distance, diffraction, field strength, absorption, Scattering, reflection, fading, ducting, critical frequency, Antenna Fundamentals -_ Dipole, half wave dipole, resonant & Non-resonant antenna. Antenna gain, directional power, Antenna Losses and efficiency, band width, beam width, band width, polarization, Types of various communication used in aircraft- VHF, UHF, HF SATCOM, Intercom, PA system, Navigation System of aircraft- safe route, economy, shortest possible route, Flight Data Recorder(FDR) and Cock Pit Voice Recorder (CVR), Location of FDR and CVR, Radar range equation, Purpose and use RADAR in various fields, meaning of Primary RADAR, Secondary RADAR- advantages, disadvantages, Secondary RADARS , Doppler RADAR, INS, GPS.

AIRCRAFT ELECTRIAL SYSTEMS: 07 Marks

General requirements of Aircraft electrical system, types of wires, cables used in aircraft, methods of routing of electrical wires/cables, cable termination methods, electrical bonding, need for bonding, types of switches, relays, contactors, types of fuses, circuit breakers, bus bars, power conversion equipments, aircraft internal and external lighting system, airfield lighting system, PAPI (Precision Approach Path Indicator).

6 AIRCRAFT MAINTENANCE MANAGEMENT AND MANUFACTURING TECHNOLOGY

AIRCRAFT MAINTENANCE MANAGEMENT: 10 Marks

Failure Analysis-Concepts of failure, Early failures, Chance failures, Wear out failures, bath tub curve, Catastrophic failures, Degradation failures, Independent failures, Secondary failures, Reliability Analysis- Reliability concepts, Failure rate, MTBF, MTTF,MTTR Hazard rate, areas of reliability, Life testing and reliability, Classification of life testing, Maintainability and availability, Factors affecting maintainability, Objectives of maintenance, Forms of maintenance, Out sourcing, Built in test equipment(B I T E), Total productive maintenance(TPM), Prophylactic maintenance, Condition monitoring, Predictive maintenance, Vibration monitoring and control, Computerization of aircraft basic data maintenance, Ergonomics, Ergonomical reasons for layout of display panels ,various components/assemblies in an aircraft, ergonomics for decision making, management information system(MIS),environmental management: global environmental issues, ozone layer

depletion, regulation on pollution and prevention, function of pollution board , environment act 1986.

MANUFACTURING TECHNOLOGY: 10 Marks

Metal Removal Processes, Types Of Machine Tools – Theory Of Metal Cutting: Machinability of metal. Cutting Tool- Classification of cutting tools- Cutting Tools Materials

Centre Lathe- Various Operations, Taper Turning Methods, Thread Cutting operation, Lathe Attachments& Accessories. Drilling operations- Jigs and Fixtures- Clamping devices- Milling-Classification, - Milling cutters and classification- milling processes- Milling operations..

Types Of Grinding Processes – Cylindrical Grinding, Surface Grinding, Centre less Grinding–Super finishing process- Honing, Lapping,

Sheet metal operations like bending , forming , punching, slitting ,embossing, louvering, drawing, deep drawing. Introduction to various types of press and press tools

Casting process types. **W**elding, classification welding, types of welding, brazing, soldering Electron Beam Machining, Laser Beam Machining, Electric Discharge Machining, Introduction to CNC machines.

7. Helicopter Basics: **10 Marks**

Various configurations of helicopter. Various controls, rotors and engines with their type currently in use of helicopter Understanding the concept of Relative Wind Blade Pitch Angle Powered Flight and its aerodynamics Hovering flight and its aerodynamics Coning of Main rotors Principle of Gyroscopic Precession Concept of Ground effect during Hovering(OGE and IGE)Vertical Flight and its relation with Collective Pitch Translational Flights and aerodynamic forces Forward Flight Sideward Flight Rearward Flight Turning Flight methods of tilting Rotor Disc Concept of Auto Rotation

concept of Flapping, Feathering and Lead lag Vibration in Helicopters Groups of Vibrations and definition , Sources of Vibration ,Ways and methods to Overcome vibrations Concept of Torque Reaction and Directional control Balancing torque reaction Tail rotor and its pitch change mechanism Main Structural components of helicopter their types, material, purpose and location Fuselage (cabin, centre section, tail boom) Stabilizer Landing gears Types of gear box – bevel, helical, spur, worm, planetary gear box Tail rotor gear box – need for tail rotor gear box ,pitch change mechanism

Main mechanical systems their construction ,purpose and location , Transmission system Main gear box Tail gear box, Clutch, Freewheeling unit Main rotor head Main Flight Control Systems their purpose, construction and location Collective Pitch Control Throttle Control ,Governor ,Cyclic Pitch Controls Anti torque pedals Swash plates Hydraulic System ,Purpose components and their function

Fuel Systems Fuel supply System Lubricating system ,its purpose and functioning

Introduction to sources of power and its major components Introduction to Starting systems and its major items Introduction to Lighting systems.