Ground Examination Syllabus

Commercial Pilot's Licence (Aeroplanes)

Commercial Pilot's Licence (Helicopters and Gyroplanes)

Airline Transport Pilot's Licence (Helicopters and Gyroplanes)

AIRCRAFT (GENERAL) SYLLABUS

1. PRINCIPLES OF FLIGHT

1.1	**Principles of Flight and Flying Controls Aeroplanes**
1.1.1	Definitions
1.1.1.1	Components of aeroplane; stress terms, structural terms, materials used, fatigue
1.1.1.2	Aeroplane configurations; definitions of shape and reference
1.1.1.3	Units of measurement; length area, volume, velocity, mass, weight, pressure(static, dynamic, total), temperature, density, force, power, energy
1.1.1.4	Airspeeds: IAS, RAS/CAS, EAS, TAS
1.1.1.5	Reference speeds
1.1.1.6	Terms used to describe aerodynamic phenomena; boundary layer, laminar flow, turbulent flow, separated flow, ground effect
1.1.1.7	Abbreviations
1.1.2	Derivation of Lift
1.1.2.1	Equation of Continuity; mass flow
1.1.2.2	Bernoulli's Theorem
1.1.2.3	Streamline flow
1.1.2.4	Angle of attack; 'incidence'
1.1.2.5	Pressure distribution about a wing (transverse and longitudinal)
1.1.2.6	Centre of pressure; pitching moment
1.1.2.7	Wing shape (plan and section); its effect on lift
1.1.2.8	Lift formula
1.1.3	Drag
1.1.3.1	Profile drag; causes, boundary layer, variation with speed, methods of minimising it
1.1.3.2	Induced drag; causes, vortices, variation with speed, design factors affecting it
1.1.3.3	Interference drag
1.1.3.4	Total effect of the combination of profile and induced drag
1.1.3.5	Lift/drag ratio; variation with angle of attack, implications, operational considerations
1.1.4	Distribution of Forces - Balance
1.1.4.1	Lift/weight and thrust/drag couples
1.1 4.2	Necessity to achieve balance
1.1 4.3	Methods of achieving balance, cp/cg relationship, trim, fuselage bending (sailplane loading)
1.1.4.4	Trim Drag
1.1.4.5	Force and power situations in various phases of flight; thrust required/available, power required/available, take-off, manoeuvre, climb,

	cruise (range, endurance, propeller/jet), descent, landing
1.1.4.6	Turning
1.1.4.7	Lateral force distribution; wing bending
1.1.5	Stability
1.1.5.1	Aircraft axes and planes of rotation
1.1 5.2	Static stability
1.1.5.3	Dynamic stability
1.1.5.4	Effects of design features on stability; longitudinal, lateral, directional
1.1.5.5	Inter-action between stability in different planes
1.1.5.6	Effect of altitude/speed on stability
1.1.5.7	Speed stability
1.1.5 8	Yaw and roll
1.1.5.9	Autostabilisation; yaw and roll dampers, autothrottle
1.1.5.10	Asymmetric effects
1.1.6	Stalling
1.1.6.1	Angle of attack
1.1.6.2	Boundary layer and reasons for stalling
1.1.6.3	Variation of lift and drag in the stall
1.1.6.4	Movement of the centre of pressure
1.1.6.5	Symptoms of the stall, stall detection, desirable characteristics
1.1.6.6	Tip stalling; its dangers and methods of minimising them
1.1.6.7	Effect of separated flow over horizontal stabiliser; design configuration
1.1.6 8	Stall warning devices
1.1.6.9	Stall recovery
1.1.6.10	Stick pushers
1.1.6 11	Stalling speed variations; manoeuvres, weight, configuration
1.1.6.12	The spin (autorotation)
1.1.7	Lift Augmentation
1.1.7 1	Trailing-edge devices; terminology, effects, advantages and disadvantages
1.1.7.2	Leading-edge devices; terminology, effects, advantages and disadvantages
1 1.7.3	Effect of lift augmentation devices on lift/drag ratio
1.1.7 4	Flight deck controls and indicators
1.1.8	Flying Controls
1.1.8.1	Ailerons, elevators, rudder, spoilers/airbrakes, elevons, flying tail, trimming sailplane
1.1.8.2	Effects; primary, secondary, primary and secondary control surfaces
1.1.8.3	Flutter; causes, mass balance
1.1.8.4	Actuation; manual controls, aerodynamic balance and methods used, powered controls, methods of transmitting demands to control surfaces, feedback of control surface hinge moment, feel (natural/artificial), feel systems
1.1.8.5	Trim; mechanical, aerodynamic, flight deck controls and indicators
1.1.9	Autopilots
1.1.9.1	Function and application
1.1.9.2	Types; different axes
1.1.9.3	Component diagram
1.1.9.4	Modes; lateral, longitudinal, common
1.1.9.5	System concepts for autoland; go around, take-off, fail passive, fail operational (redundant)

1.1.9.6	Control mode
1.1.9.7	System monitoring
1.1.10	Asymmetric Flight
1.1.10.1	Minimum Control Speeds
1.1.10.2	Effect of Ambient Conditions
1.1.11	Propellers
1.1.11.1	Conversion of Engine Torque to Thrust
1.1.11.2	Meaning of Geometric Pitch, effective pitch
1.1.11.3	Angle of Attack; blade angle
1.1.11.4	Reasons for Blade Twist
1.1.11.5	Propeller Efficiency
1.1.11.6	Windmilling Drag
1.1.11.7	Propeller Effects; torque reaction, gyroscopic effect, blade effect, slipstream effect
1.1.11.8	Forces Acting on a Propeller; centrifugal twisting moment, aerodynamic twisting moment, thrust, torque
1.1.11.9	Fixed Pitch Propeller Disadvantages
1.1.11.10	Materials; fatigue
1.1.12	Transonic Flight
1.1.12.1	Shock Waves; the reasons for their formation at subsonic aircraft speeds, effect on handling and operation, sonic buffet and its similarity to aerodynamic stall, wave drag, MCRIT, 'supercritical' terminology
1.1.13	Aerodynamic Limitations
1.1.13.1	EAS/IAS/TAS/M; dynamic pressure, margins
1.1.13.2	Manoeuvring and Gust Envelope
1.1.14	Performance Degradation
1.1.14.1	Adverse effect on performance due to profile contamination including; icing, rain, modification to and condition of the airframe

1.2	**Helicopter Principles of Flight and Controls, Rotors and Transmissions**
1.2.1	Principles of Flight
1.2.1.1	Units of Measurement; length, area, volume, speed, velocity, acceleration, mass, weight, pressure, temperature, density, force, work, energy (kinetic, potential, pressure), power
1.2.1.2	Newton's 'Laws of Motion'; inertia, momentum
1.2.1.3	Resolution of Forces, moments, couples, torque, vectors, resultants, equilibrium, centre of gravity
1.2.1.4	Airflow; flat plate (airflow around), turbulence (force from),streamlining (streamlines and flow), Bernoulli's Theorem, the venturi, aerofoil (airflow over, pressure distribution transverse and longitudinal, centre of pressure, stagnation point, transition point, separation point)
1.2.1.5	Lift; Bernoulli's Theorem (relevance of), angle of attack, total reaction, lift formula, wing shape (plan and sections, and its effects on lift and centre of pressure movement), coefficient of lift curve
1.2.1.6	Drag; zero lift drag (surface friction, form drag, interference drag, variation with speed), induced or lift dependent drag (causes, vortices, variation with speed, design factors affecting), laminar flow, boundary layer, fineness ratio/aspect ratio, viscosity, total drag and drag formula, coefficient of drag curve, lift/drag ratio and curve, compressibility/wave drag

1.2.1.7	Stalling; angle of attack (CL curve), boundary layer and reasons for stall, lift and drag variation at the stall, movement of centre of pressure at the stall, wing tip stall (dangers and methods of minimising), stall symptoms, stall (recovery from), effect of manoeuvre on the stall speed
1.2.1.8	Forces on Fixed Wing Aircraft in Flight; level flight (four forces, pitching moments and couples, effect of weight and speed for a given angle of attack, sailplane and elevator), climbing (four forces, angle and rate of climb, effect of weight), gliding flight and the three forces involved, relevance of lift/drag ratio, effect of wind on range, effect of weight on range and endurance, turning flight (four forces, load factor)
1.2.1.9	Stability; static stability, dynamic stability, aircraft axes and planes of rotation, effects of design features, inter-action between stability in different planes, effect of altitude and speed
1.2.2	Helicopter principles
1.2.2.1	The Helicopter and Associated Terminology; comparison with fixed wing and autogyro, plane of rotation, axes of rotation, rotor shaft axis, tip path plane, rotor disc, disc loading, blade loading
1.2.2.2	The Forces Diagram and Associated Terminology; pitch angle, rotational airflow, induced airflow, airflow relative to the blade, angle of attack, lift (blade), drag (blade), total reaction (blade), rotor thrust, rotor drag, torque, weight
1.2.2.3	Uniformity of Rotor Thrust Along Blade Span; washout, taper, coning angle, centrifugal force, limits of rotor rpm, centrifugal turning moments
1.2.2.4	Helicopter Controls, collective lever (collective pitch changes), relationship with rotor thrust and rotor drag, cyclic stick, cyclic pitch changes, rotor disc attitude, rotor thrust tilt, yaw pedals, fuselage torque, tail rotor drift, tail rotor roll, fenestron tail, tandem rotors, co-axial rotors, notar
1.2.2.5	Rotor Blade Freedom of Movement; feathering (the feathering hinge, pitch angle), flapping (the flapping hinge, alleviation of bending stresses, flapping to equality, dragging, the drag hinge, drag dampers, leading/lagging, periodic drag changes, blade C of G including conservation of angular momentum, Hookes joint effect)
1.2.2.6	Phase Lag and Advance Angle; the control orbit, pitch operating arm movement, rate of pitch change, rate of blade flapping, resulting disc attitude, phase lag (definition), advance angle (definition)
1.2.2.7	Vertical Flight; take off, vertical climb, vertical descent, hover outside ground effect, ground effect, factors effecting ground cushion, ground resonance (causes and recovery actions), dynamic roll over (avoidance of)
1.2.2.8	Forces in Balance; at the hover, in forward flight, influence of centre of gravity, influence of stabilisers, influence of rotor shaft tilt
1.2.2.9	Translational Lift; effect of horizontal airflow on induced flow, variation of total flow through the disc with forward flight, the relationship between pitch angle and angle of attack
1.2.2.10	Power Requirements, rotor profile power, power absorption (tail rotor and ancillary equipment), rotor profile power variation with forward speed, induced power, parasite power, total power required, power available
1.2.2.11	Further Aerodynamics of Forward Flight; transition from and to the hover,

symmetry-and dissymmetry of rotor thrust, main rotor flapback, tail rotor flapback and methods of removal, factors affecting maximum forward speed (design limits of cyclic stick, airflow reversal, retreating blade stall, symptoms and recovery actions, compressibility including flow separation the shock stall and the 'G' Stall), inflow roll

1.2.2.12 Factors Affecting Cyclic Stick Limits; all up weight, density altitude, centre of gravity position

1.2.2.13 The Flare - Powered Flight, thrust reversal, effect on aircraft attitude, increase in rotor thrust, decrease in rotor drag, increase in rotor rpm, effect of deceleration

1.2.2.14 Vortex Ring; tip vortices, comparison of induced flow and external flow, development, change in relative airflow along blade span (root stall and turbulence), effect of increasing power, symptoms and recovery action, avoidance

1.2.2.15 Blade Sailing; rotor RPM and blade rigidity, effect of adverse wind, minimising the danger

1.2.2.16 Autorotation (vertical); rate of descent airflow, effective airflow, relative airflow, inflow and inflow angle, autorotative force, rotor drag, effect of weight and altitude, control of rotor RPM with lever, rotor RPM stability

1.2.2.17 Autorotation (Forward Flight); factors affecting inflow angle, effect of forward

speed on rate of descent, dissymmetry of autorotative disc area in forward flight, turning, the flare (rotor RPM increase from movement of autorotative section, increase in rotor thrust, reduction in rate of descent), range and endurance, autorotative landing, height/velocity avoid graph

1.2.2.18 Stability; hover, forward flight, rearward flight, stability aids (stabilisers and effects of centre of gravity, gyro controlled stabiliser systems, stabiliser bars, delta hinge effect), effect of lever application on attitude in translational flight

1.2.2.19 Control Power, the teetering head, fully articulated head, the rigid rotor, effect on stability, effect on dynamic rollover

1.2.2.20 Power Requirements (graphs); power required/power available graph, maximum rate of climb speed, operating with limited power, best angle of climb speed, maximum speed, range and endurance, overpitching, overtorquing, turning, comparison of piston and turbine engined helicopters (range and endurance, effect of density altitude, effect of aircraft weight)

1.2.3 Rotor Control Systems

1.2.3.1 Types of Control System; push-pull rods and bell cranks, cables and pulleys, chains, teleflex, bowden Cables

1.2.3.2 Adjustments; end fittings, turnbuckles and tensiometers, primary and secondary stops

1.2.3.3 Primary Controls; cyclic, collective, directional, throttle, swash plate, spiders, cross coupling, correlation, mode of actuation (manual, hydraulic), friction, feel, trim

1.2.3.4 Types of Rotor Head and Components; fully articulated (hubs, flapping hinges/elastomerics, lead/lag hinges/elastomerics, feathering hinges/ bearings/elastomerics, dampers, pitch operating rods, pitch control arms/advance angle, droop stops/flapping restrainers), semi-rigid (hubs, teetering/ flapping hinges, feathering hinges, blade sleeve retention, drag bracing, pitch operating rods, pitch control arms/advance angle, droop

	stops/flapping restrainers, bump stops), rigid/hingeless description and materials, tail rotors (Fenestron etc., Delta 3 hinges, Delta 3 effect)
1.2.3.5	Main Rotor Blades; lift distribution (taper, washout), section (symmetrical, droop snoot, BERP), construction (Extruded spar, fabricated, composite), balancing (chordwise, spanwise), tracking (flag method, Chadwick Helmuth, adjustments)
1.2.3.6	Tail Rotor Blades, construction, balancing
1.2.4	Transmission Systems
1.2.4.1	Functions; drive to all rotors, speed changes, direction of drive, necessary angles of drive, accessory drives
1.2.4.2.	Components; gearboxes, construction (gear types, lubrication, magnetic plugs, chip detectors, oil sampling), clutches/free turbines, freewheel units, drive shafts/support bearings, flexible couplings, rotor brakes
1.2.4.3	Indications; R.P.M., torque, oil temperatures, chip warnings
1.2.4.4	Checking; run-out, balancing, vibration
1.2.4.5	Hazardous Incidents; overspeed, overtorque, sudden stoppages

2 ENGINES

2.1 Piston and Gas Turbine Engines

2.1.1	Piston Engines
2.1.1.1	Basic Gas Laws; Boyles Law, Charles Law
2.1.1.2	Heat; conversion of heat energy to mechanical energy, transfer of heat (conduction, convection, radiation)
2.1.1.3	Newton's Laws of Motion; mass, force, weight, momentum, inertia
2.1.1.4	Power; units of power (watt), horsepower (brake horse power, indicated horse power, thrust horse power, shaft horse power), factors which effect power output, controlling power output rpm/mp
2.1.1.5	Piston Engine Construction and Operation; engine nomenclature (major parts and assemblies, cylinder terminology), principle of operation (four stroke cycle, valve timing, ignition timing, schematic construction and functioning
2.1.1.6	Engine Efficiencies; mechanical efficiency, thermal efficiency, volumetric efficiency
2.1.1.7	Carburation; fuels (types, grades), automobile fuel, combustion process (mixture ratios), detonation (contributing factors, effects and indications, stopping and prevention), pre-ignition (contributing factors, effects and indications, stopping and prevention
2.1.1.8	Carburettors; basic float carburettor (float chamber, jets, air bleeds, idling system, accelerator pump, economiser system, mixture control system), direct fuel injection (fuel injection pump, fuel/air control unit, fuel manifold valve, fuel discharge nozzle), carburettor icing (vaporisation, laws of evaporation, carburettor ice formation, carburettor intake heating, effect of ice on engine performance), carburettor induction system (alternate air, air filter, intake blockage indication and symptoms)
2.1.1.9	Power Augmentation Devices; turbo-charger, controllers, waste-gate, secondary effects of turbo-charging, supercharging
2.1.1.10	Fuel Delivery; simple aircraft fuel system, engine priming, fuel system controls
2.1.1.11	Lubrication and Cooling; oil types and grades, oil functions, lubrication

methods, system components (filters, relief valves, temperature control, wet sump system, dry sump system), air cooling (importance of cooling, control of cylinder airflow and temperature)

2.1.1.12 Ignition System; high tension magneto (points, capacitor, distribution), reasons for pressurising magnetos, impulse coupling, low tension coil

2.1.1.13 Engine Instruments; rpm, manifold pressure, oil pressure, oil temperature, cylinder head temperature, exhaust gas temperature, fuel flow and pressure, induction system temperature gauge

2.1.1.14 Engine Controls; throttle, rpm, mixture, carburettor heat, cowl flap, ignition switch, engine priming pump and prime switch, alternate air

2.1.1.15 Engine Handling; pre-start inspection, starting procedure and precautions, shut down procedure, after start checks and testing, procedure for changing power settings

2.1.1.16 Engine Performance; manifold pressure versus rpm, propeller load, effect of altitude/temperature on performance, effects of fuel/air ratio, best power, best economy, carburettor air temperature, exhaust back pressure, cruise control (range and speed charts, power setting)

2.1.1.17 Engine Running Faults; incorrect temperature and pressures, rough running, vibration, loss of power, trouble shooting procedure

2.1.1.18 Propellers (reason for variable/constant speed propellers); blade pitch positions

(flight fine pitch, ground fine pitch, coarse pitch, feather, reverse pitch), propeller efficiency, construction and operation (single acting propeller, double acting propeller), constant speed unit (on-speed, over-speed, under-speed, feather/unfeather, unfeathering accumulator, feathering pump, automatic feathering, Beta control, negative torque sensing, synchronisation, synchrophase), design features for power absorption

2.1.2 Turbine Engines

2.1.2 1 Basic Principles; theory of jet propulsion, (Newton's Laws of Motion), working cycle (gas flow, changes in pressure, velocity, temperature, constant pressure cycle)

2.1.2.2 Engine Developments; engine efficiencies (propulsive efficiency, thermal efficiency, overall efficiency), basic mechanical arrangements (turbojets, turbo props, turbo-shafts, by-pass engines, spool arrangements-single/twin/triple), relative propulsive efficiencies (advantages/disadvantages, mechanical arrangement)

2.1.2.3 Engine Construction; intakes (subsonic), compressors (centrifugal, axial, spool arrangements-single/twin/triple, compressor characteristics, effects of blade damage and/or deterioration), combustion systems (multichamber, tubo-annular, annular, air fuel ratios, cooling and dilution flows, methods of atomisation and vapourisation), turbines (single/twin/triple spool, impulse/reaction, shrouding/unshrouding, active clearance control, blade and disc cooling, creep/thermal fatigue/thermal shock, free power turbines), exhausts (collectors, jet pipe, propelling nozzles, pressure thrust, methods of noise reduction), external gearbox (drives, accessories), schematic construction and functioning

2.1.2.4 Operation and Requirements of Engine Systems, oil system (types of approved oils/mixing, full flow system, relief valve system, system components,

control/inspection MCD's, instrumentation/interpretation), internal air systems (cooling and sealing flows, turbine overheat-action/drills), fuel systems (types of fuel and requirements, fuel flow versus rpm/engine pressure ratios, normal demand, acceleration/decal control, surge and extinction, system components, principles of control systems, pressure control/electronic full and limited authority, automatic control for day tamp/press, temp/rpm limiters), starting (air starters, electric starters, system components, typical start procedure/instruments, start problems-hot/wet/hung, dry motoring, relighting relight envelope), thrust augmentation (water-meth, water injection, system components)

2.1.2.5 Pod/Nacelle; cooling and ventilation, zones, air supplies, fire protection (detection' extinguisher, instrumentation- action/drills), anti-icing (hot air, electrical, combined systems, instrumentation), thrust reverse (hot stream spoilers, hot stream reversal, cold stream reversal, instrumentation, safety features)

2.1.2.6 Operation of Gas Turbines; selection and control of thrust (control parameters), instrumentation (thrust/epr, rpm, turbine gas temperature, vibration, electronic displays), performance (effect of OAT/press altitude/environmental envelope, effect of changes in rpm/tgt/epr etc. tgt/rpm/epr limitations effect of bleed air on thrust/exhaust temp/rpm/ pressure, flat rating), airflow control (blade stall, stage stall, rotating stall, surge, pressure ratio vs mass flow, control systems bleed valves, VIGVs, electronic control systems)

2.1.2.7 Auxiliary Power Unit (APU); function and types, operation and monitoring

3 ELECTRICS

3.1 Direct Current (DC)

3.1.1 Definitions; electron, potential difference, electromotive force, voltage, current, resistance, power

3.1.2 Ohm's Law

3.1.3 Resistance Calculations; series circuit, parallel circuit

3.1 4 Resistance (as a function of); temperature, conductor cross sectional area and length

3.1.5 Kirchoffs Law

3.1.6 Current and Voltage Calculations; series circuit, parallel circuit

3.1.7 Electrical Power and Work

3.1.8 Basic Circuit Components and Symbols; generator, battery, switch, relay, earth, fuse, circuit breaker, resistance, condenser/capacitor

3.1.9 Electrical Unit Prefixes; megohm, kilovolt, milliamp, microvolt

3.1.10 Batteries; lead acid (construction, electrolyte composition, cell terminal voltage, electrolyte specific gravity-indications of battery charge state, ampere hour ratings), nickel cadmium battery (construction, electrolyte composition, electrolyte S. G. characteristics-indications of battery charge state, cell terminal voltage, thermal runaway and cockpit indications, ampere-hour ratings

3.1.11 Aircraft Systems; purpose, checking for serviceability-Pilot orientated, effects of overcharging, effects of leaving a battery in a discharged state, voltage and ampere hour resulting from series and parallel connection, spilt electrolyte

	neutralising agents
3.1.12	Aircraft Wiring and Circuit Protection; unipole, all-pole, earth return, bonding and discharge wicks, screening, short circuit, open circuit, fuses, current limiters, circuit breakers, trip free, non trip free, reverse current circuit breaker
3.1.13	Permanent Magnetism
3.1.14	Electromagnetism, solenoid, relay(contactor), reverse current cut out
3.1.15	Electromagnetic Induction
3.1.16	Electromagnetic Power; direct current generators (construction -rotating armature with commutator, the electrical field, shunt wound, series wound, compound wound, voltage control and indications), alternators producing direct current by rectification (construction, the electrical field-external excitation, slip rings and brushes, voltage control and indications)
3.1.17	Generator Control, voltage regulator, reverse current cut out, monitoring instruments (ammeter, loadmeter, voltmeter, magnetic indicators), field flashing and reset facility, paralleling, differential voltage control, load sharing and equalising circuit, normal indications and operation, emergency indications and follow up actions
3.1.18	Bus Bar Distribution and Protection; essential consumers, non essential consumers, emergency consumers, battery supplied consumers (fire detection and protection, emergency lights, emergency instruments)
3.1.19	Direct Current Motors; construction, field windings (shunt, series, compound)
3.1.20	Starter Generator; control function and application
3.1.21	Inverter; control function and application
3.1.22	Actuators; rotary (control function and application), Linear (control function and application)
3.1.23	Ground Power Unit (D.C.), purpose, aircraft circuit protection
3.2	**Alternating Current (A. C.)**
3.2.1	Nature of Alternating E.M.F. and Current; sine wave format, rms value
3.2.2	Advantages and Disadvantages Compared to Direct Current
3.2.3	Inductance; inductive reactance, current and volts phase relation, frequency variation and effect, definition of units and formula
3.2.4	Capacitance; capacitive reaction, current and volts phase relation, frequency variation and effect, definition of units and formula
3.2.5	Power in A.C. Circuits; true and apparent power (units (kVA) and (kV) defined), reactive power, unit (kVAR) defined
3.2.6	Impedance defined
3.2.7	Alternating Current Generator Three Phase Brushless; construction-internal excitation (stators and terminal connections, rotor and field winding, field excitation, number of rotor poles in general use, determination of frequency = PN/120 Hertz)
3.2.8	Power Derivation; star wound stators (phase voltage -115v, line voltage -200v, current value), delta wound stators, (phase current, line current, voltage value)
3.2.9	Generator Control and Protection Unit (G.C.P.U.); voltage sensing and regulation (over and under frequency monitoring, over and under voltage monitoring, field excitation and control-sampling circuit)
3.2.10	Multiple A.C. Generator Operation; paralleling and load sharing (constant speed drive unit-CSDU-and cooling method. integrated drive system and

cooling method, fault indication and disconnect facility)

3.2.11 Power Distribution and Application (A.C.); split bus bar (frequency wild supply), tied bus bar (synchronised generator output), combining bus bar (independent or synchronised generator output), Single/multi-phase consumer equipment

3.2.12 Monitoring Equipment; phase discriminator, synchronising lights, voltmeter, frequency meter, kW/kVAR meter (True and reactive loads), failure warning lights (field trip, overheat, constant speed drive unit (CSDU) oil pressure and temperature

3.2.13 Transformers and Function in A.C. Electrical Units

3.2.14 Transformer Rectifier Unit (TRU); direct current distribution

3.2.15 Use of Inverters in A.C. Circuits

3.2.16 Fault Diagnosis and In Flight Emergency Operation; essential consumers, non essential consumers, emergency supplied consumers, load shedding

3.2.17 Alternating Current Motors:; control function and application of general purpose (series), induction (three phase and single phase), and synchronous

3.2.18 Ram Air Turbine (RAT), construction and control, application

3.2.19 Ground Power Unit (A.C.); purpose and control, aircraft protection circuits, external power connection method

3.3 **Semiconductors**

3.3.1 Principle and Application to; resistors, rectifiers, transistors

3.4 Logic Circuits

3.4.1 Principle and Application to Aircraft Systems, logic symbols, switching circuits

3.5 Electronic Display Systems

3.5.1 Electronic flight instrument system (EFIS)

4 SYSTEMS

4.1 **Hydraulics**

4.1.1 Basic Principles of Hydromechanics

4.1.1.1 The General Principles of Transmission of Force by Fluid Under Pressure.

4.1.1.2 The Means by Which Pressure is Produced and Controlled in a System.

4.1.1.3 Schematic Construction and Functioning of Hydraulic Systems.

4.1.1.4 Hydraulic Fluids; the requirements of hydraulic fluids, the characteristics of hydraulic fluids, safety consideration

4.1.2 Hydraulic Systems

4.1.2.1 Main, Standby and Emergency Systems; constant pressure and constant delivery, engine driven, air driven, electrically driven, ram air turbines

4.1.2.2 Accumulators; function, role as a safety feature

4.1.2.3 Filters; indications and maintenance

4.1.2.4 Valves; associated with normal system operation, incorporated as a safety feature

4.1.2.5 Seals; function and failures

4.1.2.6 Operation, Indicators and Warning Systems

4.1.2.7 Fluids; storage, reservoirs, supply, replenishment and quantity indications, temperature and pressure control and indications, safety precautions

4.1.2.8	Systems Operated by Hydraulic Power; flying controls (including artificial feel, flaps. spoilers, speedbrakes, trim and autopilot), landing gear, wheelbrakes, nosewheel and body gear steering
4.2	**Pneumatics**
4.2.1	Power sources
4.2.1.1	The compression process
4.2.1.2	Engine driven compressors
4.2.1.3	Engine bleed air (gas turbines)
4.2.1.4	Turbocharger compressor bleed air, displacement blower (piston engines)
4.2.1.5	APU
4.2.1.6	Emergency supplies: air bottles, 'cross-bleed starting'
4.2.1.7	Schematic construction of the foregoing system/components including operation, indication, protection, failures, warning and safety devices
4.2.2	Air conditioning system
4.2.2.1	Requirements, human factors, altitude physiology
4.2.2.2	Supplies: bleed air bootstrap system (air cycle machine), displacement blower, vapour cycle, ram air systems
4.2.2.3	Schematic construction and operation
4.2.2.4	Distribution and temperature control: automatic/manual, indicators, protection failures, warning and safety devices
4.2.2.5	Ram air ventilation
4.2.2.6	Avionics and cargo hold conditioning
4.2.3	Pressurisation
4.2.3.1	Requirements, human factors
4.2.3.2	Aircraft pressurised zones, pressurisation cycles, stresses
4.2.3.3	Pressure control: automatic, semi-automatic, manual and standby modes, schematic construction, operation and indication
4.2.3.4	Cabin altitude: relationship to outside altitude, maximum cabin altitude, maximum and nominal cabin differential pressure, positive and negative differential pressure, rate of change of differential pressure, flight profiles
4.2.3.5	Monitoring: controls, indication, failures, warning, design safety features
4.2.3.6	Cabin altitude warning: incipient decompression, rapid and explosive decompression, emergency procedures
4.2.4	Systems actuation
4.2.4.1	Landing gear: operation including nose wheel steering and brakes, control and indication, failures and warning devices
4.2.4.2	Flight controls, leading and trailing edge flaps, control and indication
4.2.4.3	Wing and engine anti/de-icing: leading edges, control surfaces and engine intakes, control and indication, limitations, failures and warning devices
4.2.4.4	Schematic construction of the foregoing
4.2.4.5	Other requirements: doors, cargo compartment and hydraulic pressurisation
4.3	**Fuel Systems**
4.3.1	Fuel Tanks
4.3.1.1	Structural; components and types
4.3.1.2	Location; single and multi-engine aircraft
4.3.1.3	Sump Drains
4.3.1.4	Tank Vents

4.3.2	Re-fuelling/de-fuelling
4.3.2.1	Grades of Fuel, MOGAS (implications of use), AVGAS, AVTUR (JP1/JP4)
4.3.2.2	Colour Coding of Aircraft Fuelling Points and Ground Installations
4.3.2.3	Density of Various Fuels
4.3.2.4	Characteristics of Fuels; octane rating, flash point, waxing point, colour coding, additives
4.3.2.5	Sequence and Types of Re-fuelling; underwing/overwing, precautions to be observed
4.3.3	Fuel Feed
4.3.3.1	Location of Fuel Pumps
4.3.3.2	Gravity and Pressure Feed
4.3.3.3	Pump(s); failure in flight
4.3.3.4	Precautions to be Observed When Using MOGAS/JP1
4.3.3.5	Crossfeed System
4.3.3.6	Knowledge of Schematic System
4.3.3.7	Unusable Fuel
4.3.4	Fuel Dumping (Jettisoning)
4.3.4.1	National Legislation; aircraft performance aspects
4.3.4.2	Knowledge of Schematic System
4.3.4.3	Precautions to be Observed
4.3.4.4	Procedures, prior/during/after dumping
4.3.4.5	Minimum Fuel
4.3.5	Fuel System Monitoring
4.3.5.1	Importance of Fuel Management
4.3.5.2	Operation of System; indicators, warning system(s), system schematic knowledge
4.3.5.3	Balancing of Fuel; operational imbalance (lateral and longitudinal), engine out configuration.
4.3.5.4	Fuel Temperature; anti-waxing precautions
4.3.5.5	Fuel De-icing Procedure(s)

4.4	**Ice and Rain Protection**
4.4.1	Requirements
4.4.1.1	Anti-Ice, De-Ice
4.4.2	Ice warning
4.4.3	Pneumatic ice protection systems
4.4.3.1	Leading Edges of Flying Surfaces
4.4.3.2	Schematic Construction and Functioning
4.4.3.3	Operation of the System; limitations
4.4.3.4	Initiation; timing
4.4.3.5	Controls; indicators, protection, warnings
4.4.4	Thermal Ice Protection Systems
4.4.4.1	Propeller blades, air intakes, flying surfaces, pitot and other sensors, windshields
4.4.4.2	Methods; electrical, air, oil
4.4.4.3	Schematic Construction and Functioning
4.4.4.4	Operation of the System; limitations
4.4.4.5	Initiation; timing
4.4.4.6	Controls; indicators, protection, warnings

4.4.5	Fluid Ice Protection Systems
4.4.5.1	Leading edges of flying surfaces, propellers
4.4.5.2	Schematic Construction and Functioning
4.4.5.3	Operation of the System; limitations
4.4.5.4	Initiation; timing
4.4.5.5	Controls; indicators, protection, warnings
4.4.6	Rain Removal
4.4.7	Ground de-icing
4.4.8	Effects on aircraft performance
4.5	**Landing Gear and Wheel Braking Systems**
4.5.1	Landing Gear
4.5.1.1	Types; fixed, retractable
4.5.1.2	Construction; main components
4.5.1.3	Sources of Power; normal operation, alternate and emergency operation
4.5.1.4	Locking Devices and Emergency Extension Systems
4.5.1 5	Accidental Retraction Prevention Devices
4.5.1.6	Air/Ground Logic; sensor systems
4.5.1.7	Position; movement lights and indicators
4.5.1 8	Steering; nosewheel steering, body gear steering, turning radius
4.5.1.9	Wheels and Tyres; construction, condition (creep, wear, cuts, pressure, contamination), limitations including tyre limiting speed
4.5.2	Wheel braking systems
4.5.2.1	Types
4.5.2.2	Construction, main components
4.5.2.3	Parking brake; operation and indications
4.5.2.4	Alternate and reserve braking systems
4.5.2.5	Sources of Power; normal braking system, alternative and reserve braking systems
4.5.2.6	Operation (indications, warning systems); brake system pressure, brake wear indicators, brake overheat, brake energy and cooling data, performance limitations
4.5.2.7	Anti Skid Systems; principles and operation, controls and indications, limitations in the event of failure
4.5.2.8	Auto Brake Systems; principles and operation, controls and indications, rejected take-off auto brake
4.6	**Emergency Equipment**
4.6.1	As State Regulations
4.6.2	Doors and Emergency Exits
4.6.2.1	Accessibility, Location
4.6.2.2	Normal and Emergency Operation
4.6.2.3	Crew and Passenger Emergency Exits
4.6.2.4	Aircraft Emergency Lighting and Marking; cockpit/flight deck, passenger cabin, cabin floor
4.6.2.5	Evacuation Slides, general use or as life rafts or flotation devices
4.6.2.6	Aircraft cut-in areas
4.6.3	Smoke Detection
4.6.3.1	Location of detector units; toilets, cargo holds, electrical and equipment bays
4.6.3.2	System Operation

4.6.3.3	Indicators and Warnings
4.6.3.4	Functional Test
4.6.3.5	Location and Use of Smoke Protection Devices; masks/smoke hood
4.6.4	Fire detection
4.6.4.1	Type of System
4.6.4.2	Location of Detector Units in Relation to Protection; engine nacelles, wheel wells, APU
4.6.4.3	System Functional Test
4.6.4.4	Warnings
4.6.5	Fire protection (Aircraft Systems Equipment)
4.6.5.1	Location of Components, bottles etc
4.6.5.2	Pre-Flight Check of Components; gauge pressure, temperature (effects on pressure), indication of system, integrity (used bottle), functional test
4.6.5.3	System Operation; warnings
4.6.5.4	A.P.U.; pre-flight check, gauge pressure, temperature and its effects, system integrity, functional test.
4.6.6	Oxygen System and equipment
4.6.6.1	Effects of Hypoxia
4.6.6.2	Components; location, checks, system tests (crew, passenger)
4.6.6.3	Principles of Operation of Systems in Relation to; cabin altitude, automatic, manual
4.6.6.4	Protection and Surveillance Devices
4.6.6.5	Drills; use of equipment (normal operations, rapid decompression)
4.6.6.6	Comparison of Constant Flow and Demand Outlet Masks
4.6.6.7	Use of Oxygen Generators
4.6.6.8	Dangers of Oxygen Use; safety measures
4.6.6.9	Replenishment of Oxygen System
4.6.7	Emergency Equipment
4.6.7.1	Types of Portable Hand Held Fire Extinguishers.
4.6.7.2	Portable Oxygen.
4.6.7.3	Life Jackets and Life Rafts
4.6.7.4	Survival Packs; types of survival equipment, emergency locator beacon, transmitter.
4.6.7.5	Emergency Torch
4.6.7.6	Megaphone
4.6.7.7	Crash Axe
4.6.7.8	Fireproof Gloves