Appendix 2.0 B to SA-CATS 61
Airline Transport Pilot Licence syllabus

REF	1. AVIATION METEOROLOGY	A	H
1.1	THE ATMOSPHERE	√	√
	– composition	√	√
	– structure	√	√
	– International standard atmosphere (ISA)	√	√
	– ISA deviation	√	√
	– Jet standard atmosphere (JSA)	√	**n/a**
1.2	PRESSURE	√	√
1.2.1	Atmospheric pressure	√	√
	– measurement: units in use	√	√
	– QNH, QFE, QFF and 1013.25 hPa	√	√
	– mercury barometer	√	√
	– aneroid barometer	√	√
	– pressure variation with height and diurnal variation	√	√
	– isobars	√	√
1.2.2	Pressure systems	√	√
	– depressions: thermal, orographic	√	√
	– troughs and coastal lows	√	√
	– tropical cyclones	√	√
	– weather associated with depressions	√	√
	– anticyclones	√	√
	– ridges	√	√
	– anticyclonic weather	√	√
	– cols and associated weather	√	√
1.3	TEMPERATURE	√	√
	– measurement: units in use, conversion factors	√	√
	– heating of the atmosphere	√	√

REF		A	H
	– radiation	√	√
	– conduction	√	√
	– convection	√	√
	– advection	√	√
	– land and sea heating and cooling	√	√
	– diurnal variation of temperature	√	√
	– lapse rates	√	√
	– inversions	√	√
1.4	HUMIDITY	√	√
	– evaporation, saturation, condensation, freezing and melting	√	√
	– sublimation	√	√
	– humidity measurement	√	√
	– wet bulb temperature	√	√
	– dry bulb temperature	√	√
	– absolute humidity	√	√
	– relative humidity	√	√
	– dew point temperature	√	√
1.5	DENSITY	√	√
1.5.1	The gas laws	√	√
	– Boyle's law	√	√
	– Charles's law	√	√
	– the gas equation (Boyle's and Charles's laws)	√	√
1.5.2	Factors affecting density	√	√
	– temperature	√	√
	– pressure	√	√
	– altitude	√	√
	– humidity	√	√
1.5.3	Density altitude	√	√

REF		A	H
	– calculating density altitude	√	√
	– effect of density altitude on aircraft performance	√	√
1.6	ADIABATIC PROCESS, LAPSE RATE AND STABILITY	√	√
	– dry adiabatic lapse rate (DALR)	√	√
	– saturated adiabatic lapse rate (SALR)	√	√
	– environmental adiabatic lapse rate (ELR)	√	√
	– absolute stability	√	√
	– absolute instability	√	√
	– conditional instability	√	√
	– neutral stability	√	√
1.7	WIND	√	√
1.7.1	Definitions	√	√
	– veering and backing	√	√
	– gust, squall, gale, hurricane, gust factor	√	√
1.7.2	Measurement of wind	√	√
	– wind vane and anemometer	√	√
1.7.3	Formation of wind	√	√
	– pressure gradient force	√	√
	– geostrophic force	√	√
	– coriolis force	√	√
	– geostrophic wind	√	√
	– gradient wind	√	√
	– surface wind	√	√
	– diurnal variations	√	√
1.7.4	Upper winds	√	**n / a**
	– thermal wind	√	**n / a**
	– jet streams	√	**n / a**
	– clear air turbulence (CAT)	√	**n / a**

REF		A	H
1.7.5	Local winds	√	√
	– Land and Sea breezes	√	√
	– Katabatic and Anabatic winds	√	√
	– the Föhn wind	√	√
	– the Berg wind	√	√
	– Monsoons	√	√
	– Trade winds and the ITCZ	√	√
	– General global wind circulation	√	√
1.8	AIR MASSES	√	√
	– classification	√	√
	– modification	√	√
	– air masses affecting South Africa	√	√
1.9	CLOUDS	√	√
1.9.1	Cloud measurement	√	√
	– cloud amount	√	√
	– methods of measuring cloud base and cloud ceiling	√	√
1.9.2	Cloud formation	√	√
	– convective	√	√
	– orographic	√	√
	– frontal	√	√
	– convection	√	√
	– convergence	√	√
	– turbulence	√	√
1.9.3	Cloud classification	√	√
1.9.4	Cloud types	√	√
1.10	PRECIPITATION	√	√
	– Bergeron theory (ice particle theory)	√	√
	– Coalescence theory	√	√

REF		A	H
	– intensity	√	√
	– types of precipitation	√	√
1.11	Thunderstorms	√	√
1.11.1	Formation	√	√
	– conditions for the development	√	√
1.11.2	Thunderstorm classification	√	√
	– convective	√	√
	– orographic	√	√
	– advection	√	√
	– convergent	√	√
	– frontal	√	√
	– nocturnal	√	√
1.11.3	Stages of development	√	√
	– growth	√	√
	– mature	√	√
	– dissipating	√	√
	– squall lines	√	√
1.11.4	Hazards	√	√
	– turbulence/windshear	√	√
	– microbursts	√	√
	– hail/icing	√	√
	– lightning	√	√
	– avoidance	√	√
1.12	WINDSHEAR AND TURBULENCE	√	√
	– definition of windshear	√	√
	– low altitude windshear	√	√
	– causes	√	√
	– effects on aircraft in flight	√	√

REF		A	H
	– methods to counter the effects	√	√
	– definition of turbulence	√	√
	– types and causes	√	√
	– visual detection of mountain waves	√	√
	– wake turbulence	√	√
	– cause	√	√
	– influence of speed, mass and wind	√	√
	– avoidance during crossing traffic, take-off and landing	√	√
1.13	ICE ACCRETION	√	√
1.13.1	Airframe icing	√	√
	– conditions for formation	√	√
	– types of icing	√	√
	– clear ice	√	√
	– rime ice	√	√
	– mixed ice	√	√
	– rain ice	√	√
	– hoar frost	√	√
1.13.2	Engine icing	√	√
	Piston engine	√	√
	– impact icing	√	√
	– fuel icing	√	√
	– carburettor icing: cause, recognition, prevention	√	√
	gas turbine engine icing	√	√
1.14	VISIBILITY	√	√
1.14.1	Definitions	√	√
	– types of visibility: mist, fog, haze	√	√
	– visibility and measurement	√	√
	– runway visual range (RVR) and measurement	√	√

REF		A	H
1.14.2	Fog	√	√
	– radiation	√	√
	– advection	√	√
	– frontal	√	√
	– orographic (upslope)	√	√
	– steam	√	√
	– smog	√	√
1.15	FRONTS	√	√
1.15.1	Cold fronts	√	√
	– formation	√	√
	– associated clouds and weather	√	√
	– flying conditions	√	√
	– changes with the passage of the front	√	√
1.15.2	Warm fronts	√	√
	– formation	√	√
	– associated clouds and weather	√	√
	– flying conditions	√	√
	– changes with the passage of the front	√	√
1.15.3	Occlusions	√	√
	– formation	√	√
	– associated clouds and weather	√	√
1.15.4	Stationary fronts	√	√
1.16	CLIMATOLOGY	√	√
1.16.1	General world circulation	√	√
	– climatic zones	√	√
	– ITCZ: weather and seasonal movement	√	√
1.16.2	Local seasonal weather	√	√

REF		A	H
	– South African summer patterns	√	√
	– South African winter patterns	√	√
	– the South Westerly Buster	√	√
	– The Cape Doctor	√	√
	– the Black South Easter	√	√
1.17	METEOROLOGICAL INFORMATION	√	√
1.17.1	Weather analysis and forecasting	√	√
	– synoptic weather charts and symbols, station de-code	√	√
	– significant (prognostic) weather charts	√	√
	– upper winds and temperatures charts	√	√
1.17.2	Weather information for flight planning	√	√
	– interpretation of:	√	√
	– METAR	√	√
	– TAF	√	√
	– SPECI	√	√
	– SIGMET	√	√
1.17.3	Meteorological broadcasts for aviation	√	√
	– ATIS	√	√
	– VOLMET	√	√

2.0 B - ATPL syllabus

REF	2.1 FLIGHT PLANNING AND PERFORMANCE– *AEROPLANE*	A
2.1.1	AIRSPEED TERMINOLOGY AND SYMBOLS	√
	– IAS, RAS (CAS), TAS	√
	– Mach number	√
	– VA, VNO, VNE, VX, VY	√
	– VMCG, VMCA, VMC, VS, VSO	√
	– VFO, VFE, VLO, VLE, VMO	√
	– V1, VR, V2, VREF, VLOF, VMBE	√
2.1.2	METEOROLOGICAL TERMINOLOGY	√
	– International Standard Atmosphere (ISA)	√
	– OAT, IOAT, TAT, SAT, RAT	√
	– Temperature deviation from ISA	√
	– Pressure altitude, Density altitude	√
	– QNH, QFE, QNE	√
2.1.3	AERODROME TERMINOLOGY	√
	– Runway length	√
	– Take–off run available (TORA)	√
	– Take–off run required (TORR)	√
	– Take-off distance available (TODA)	√
	– Take-off distance required (TODR)	√
	– –Landing distance available (LDA)	√
	– Landing distance required (LDR)	√
	– Clearway, stopway	√
	– Displaced thresholds (permanent/temporary)	√
	– Accelerate-stop and accelerate-go	√
	– Runway slope	√
	– Runway strength (LCN/PCN)	√

REF		A
	– Balanced and Unbalanced Field Lengths	√
	– WAT limits	√
2.1.4	AEROPLANE PERFORMANCE CLASSIFICATION	√
CAR 91.08.4	Class A, B, C and D aeroplanes	√
CAR 2011 121.08.3	Net take-off flight path	√
CAR 2011 121.08.4	En route limitations with one engine inoperative	√
CAR 2011 121.08.5	En route limitations with two engines inoperative	√
2.1.5	AEROPLANE PERFORMANCE GRAPHS	√
	USE OF B747 AEROPLANE MANUAL:	√
2.1.5.1	MISCELLANEOUS	√
	– Altimeter Setting – Station Pressure	√
	– Pressure Altitude and Density Chart	√
	– Altimeter Setting – Station Pressure	√
	– Wind Vector Diagram	√
	– Drift and Wind Component Table	√
	– Fuel Tank Capacity SG vs Weight	√
2.1.5.2	TAKE-OFF PERFORMANCE	√
	– Field Length vs Gross Weight Flaps 10	√
	– Climb Limit vs Gross Weight Flaps 10	√
	– Length vs Gross Weight Flaps 20	√
	– Limit vs Gross Weight Flaps 20	√
	– Take-off EPR Pressure Altitude vs Temperature	√
	– Initial Climb EPR Pressure Altitude vs Temperature	√
	– Take-off Speeds. Flaps 10 and 20	√
2.1.5.3	CLIMB	√
	– Atmospheric Pressure Conversion. Inches/hPa	√
	– Optimum Altitude, Short Distance Cruise Altitude vs Brake Release Weight	√
	– Altitude Capability. Cruise Gross Weight vs Flight Level and Temperature	√

REF		A
	– En-Route Climb. (Time, Fuel, Distance, TAS)	√
	– Brake Release Weight vs Flight Level ISA	√
	– Brake Release Weight vs Flight Level ISA	√
	– Brake Release Weight vs Flight Level ISA + 10° C	√
	– Brake Release Weight vs Flight Level ISA + 10° C	√
	– Brake Release Weight vs Flight Level ISA + 15° C	√
	– Brake Release Weight vs Flight Level ISA + 15° C	√
	– Brake Release Weight vs Flight Level ISA + 20° C	√
	– Brake Release Weight vs Flight Level ISA + 20° C	√
2.1.5.4	CRUISE PERFORMANCE	√
	– Mach 0.84. TAS – Fuel Flow ISA	√
	– Mach 0.84. TAS – Fuel Flow ISA + 10° C	√
	– Mach 0.84. TAS – Fuel Flow ISA + 15° C	√
	– LRC TAS – Fuel Flow ISA	√
	– LRC TAS – Fuel Flow ISA + 10° C	√
	– LRC TAS – Fuel Flow ISA + 15° C	√
2.1.5.5	INTEGRATED RANGE	√
	– LRC Planning FL 270 ISA –38.5°C	√
	– LRC Planning FL 280 ISA –40.5°C	√
	– LRC Planning FL 290 ISA –42.5°C	√
	– LRC Planning FL 310 ISA –46.4°C	√
	– LRC Planning FL 330 ISA –50.4°C	√
	– LRC Planning FL 350 ISA –54.3°C	√
	– LRC Planning FL 370 ISA –56.5°C	√
	– LRC Planning FL 390 ISA –56.5°C	√
	– Mach 0.84 Cruise FL 280 ISA –40.5°C	√
	– Mach 0.84 Cruise FL 290 ISA –42.5°C	√
	– Mach 0.84 Cruise FL 310 ISA –46.4°C	√

REF		A
	– Mach 0.84 Cruise FL 330 ISA –50.4°C	√
	– Mach 0.84 Cruise FL 350 ISA –54.3°C	√
	– Mach 0.84 Cruise FL 370 ISA –56.5°C	√
	– Mach 0.84 Cruise FL 390 ISA –56.5°C	√
2.1.5.6	TOTAL TEMPERATURE AT ISA	√
2.1.5.7	SIMPLIFIED FLIGHT PLANNING	√
	– 0.84 Mach Cruise – Landing Weight 240 – 300,000 kg	√
	– 0.84 Mach Cruise – Landing Weight 180 – 240,000 kg	√
	– 350 KIAS Cruise – Landing Weight 180 – 300,000 kg	√
	– Long Range Cruise – Landing Weight 240 – 300,000 kg	√
	– Long Range Cruise – Landing weight 180 – 240,000 kg	√
	– Step Climb to Optimum Altitude	√
	– Alternate Planning – Long Range Cruise	√
	– In-Flight Diversion – Long Range Cruise	√
2.1.5.8	DESCENT, GO-AROUND AND HOLD	√
	– Descent	√
	– Go-Around EPR, Approach and Landing Speeds	√
	– Holding, VREF + 80 kts, VREF + 60 kts	√
	– 2 Hour Hold LRC	√
2.1.5.9	LANDING PERFORMANCE	√
	– Flaps 25 – Anti-Skid Operative	√
	– Flaps 25 – Anti-Skid Inoperative	√
	– Flaps 30 – Anti-Skid Operative	√
	– Flaps 30 – Anti-Skid Inoperative	√
	– Correction Table – Brakes De-activated	√
	– Correction Table – Anti-Skid Inoperative	√
2.1.5.10	OPERATION WITH ONE ENGINE INOPERATIVE	√
	– Altitude Capability	√

REF		A
	– Total Temperature at ISA	√
	– LRC, EPR, IAS, Mach, Fuel Flow – FL 060 – 180	√
	– LRC, EPR, IAS, Mach, Fuel Flow – FL 190 – 270	√
	– LRC, EPR, IAS, Mach, Fuel Flow – FL 280 – 360	√
	– In-Flight Diversion – LRC – Distance vs Fuel/Time	√
	– Holding – VREF + 80; EPR, KIAS, Fuel Flow/Engine	√
2.1.6	MASS AND BALANCE	√
2.1.6.1	Terminology:	√
	– Arm, moment, reference datum, station, centre of gravity (CG)	√
	– CG limits – forward and aft	√
	– mean aerodynamic chord (MAC), (LEMAC)	√
	– Maximum ramp and taxi mass	√
	– Maximum zero fuel mass	√
	– Empty operating mass	√
	– Use of cargo pallets	√
	– Maximum floor load	√
2.1.6.2	Calculation of CG	√
2.1.6.3	Movement of CG in flight	√
2.1.6.4	Maximum load at station	√
2.1.6.5	Ballast	√
2.1.7	PET AND PNR	√
2.1.7.1	PET (point of equal time)	√
2.1.7.1.1	– all engines operating	√
2.1.7.1.2	– one engine inoperative (critical point)	√
2.1.7.1.3	– single leg/multi leg	√
2.1.7.2	PNR (point of no return)	√
2.1.7.2.1	– with/without fuel reserve	√
2.1.7.2.2	– single leg/multi leg	√

REF		A
2.1.8	Fuel weight and Performance	√
	– specific weight	√
	– specific gravity	√
	– fuel consumption, fuel used, fuel flow, endurance	√
	– ANM/fuel ratio	√
	– GNM/fuel ratio	√
	– wind components- most economical flight level	√

REF	**2.2 FLIGHT PLANNING AND PERFORMANCE – *HELICOPTER***	H
2.2.1	AIRSPEED TERMINOLOGY AND SYMBOLS	√
	– IAS, RAS (CAS), TAS	√
	– VA, VNO, VNE, VX, VY	√
2.2.2	METEOROLOGICAL TERMINOLOGY	√
	– International Standard Atmosphere (ISA)	√
	– OAT, IOAT, TAT, SAT, RAT	√
	– Temperature deviation from ISA	√
	– Pressure altitude, Density altitude	√
	– QNH, QFE, QNE	√
2.2.3	AERODROME TERMINOLOGY	√
	– Runway length	√
	– Displaced thresholds (permanent/temporary)	√
CAR 91.08.3	HELICOPTER PERFORMANCE CLASSIFICATION	√
	– Class 1, 2 and 3 Helicopters	√
2.4	HELICOPTER PERFORMANCE OPERATING LIMITATIONS	√
CAR 2011 127.08	– Take-off, take-off flight path	√
	– En route with one or more engines inoperative	√
	– Approach and landing	√
2.2.5	HELICOPTER PERFORMANCE GRAPHS	√
	USE OF S-92S PERFORMANCE MANUAL	√
2.2.5.1	Airspeed limits	√
2.2.5.2	Take-off and landing	√
	– Gross weight, bleed air off	√
	– Gross weight, bleed air on	√
2.2.5.3	Mass and balance data	√
	– Horizontal centre of gravity chart	√
	– Weight and centre of gravity envelope	√

REF		H
	– Cockpit and cabin weight and moment tables	√
	– Usable fuel weight and moment table	√
	– Engine oil weight and moment table	√
2.2.5.4	Landing distance	√
2.2.5.5	Take-off distance tables	√
2.2.5.6	Forward climb performance, best rate of climb speed tables	√
2.2.5.7	Hover OGE	√
	– Take-off power bleed off	√
	– Take-off power bleed on	√
2.2.6	MASS AND BALANCE	√
2.2.6.1	Terminology:	√
	– Arm, moment, reference datum, station, centre of gravity (CG)	√
	– CG limits – forward and aft	√
	– CG limits – lateral	√
	– Maximum zero fuel mass	√
	– Empty operating mass	√
	– Use of cargo pallets	√
	– Maximum floor load	√
2.2.6.2	Calculation of CG	√
2.2.6.3	Movement of CG in flight	√
2.2.6.4	Maximum load at station	√
2.2.6.5	Ballast	√
2.2.7	PET AND PNR	√
2.2.7.1	PET (point of equal time)	√
2.2.7.1.1	– all engines operating	√
2.2.7.1.2	– one engine inoperative (critical point)	√
2.2.7.1.3	– single leg/multi leg	√
2.2.7.2	PNR (point of no return)	√

REF		H
2.2.7.2.1	– with/without fuel reserve	√
	– single leg/multi leg	√
2.2.8	Fuel weight and Performance	√
	– specific weight	√
	– specific gravity	√
	– fuel consumption, fuel used, fuel flow, endurance	√
	– ANM/fuel ratio	√
	– GNM/fuel ratio	√

REF	2. RADIO AIDS	A	H
3.1	Basic Radio Theory	√	√
3.1.1	Electromagnetic waves	√	√
	– frequency, wave length, cycle, phase, amplitude	√	√
	– frequency bands	√	√
	– sidebands, double sideband, single sideband,	√	√
	– band width	√	√
	– carrier wave, modulation, demodulation	√	√
	– amplitude modulation	√	√
	– frequency modulation	√	√
	– pulse modulation	√	√
	– designation of emission	√	√
	– signal/noise ratio	√	√
3.1.2	Antennas	√	√
	– characteristics	√	√
	– polarisation	√	√
	– polar diagram	√	√
	– types of antennas	√	√
3.1.3	Wave propagation	√	√
	– ground waves	√	√
	– direct waves	√	√
	– sky waves	√	√
	– ionosphere, critical angle, skip distance	√	√
	– dead space, refraction	√	√
	– fading	√	√
	– factors affecting propagation (reflection, absorption, attenuation, coastline, mountain, static)	√	√
3.2	AUTOMATIC DIRECTION FINDER (ADF)	√	√
	ADF loop theory, rotating and fixed loop antennas	√	√

REF		A	H
	– principles	√	√
	– frequencies	√	√
	– presentation and interpretation (RBI and RMI)	√	√
	Non-Direction beacons (NDB)	√	√
	– range and coverage	√	√
	– errors and accuracy	√	√
	– factors affecting range and accuracy	√	√
3.3	VHF OMNI-DIRECTIONAL RANGE (VOR)	√	√
	- principles	√	√
	– frequencies	√	√
	– presentation and interpretation	√	√
	– range and coverage	√	√
	– errors and accuracy	√	√
	– factors affecting range and accuracy	√	√
	– CDI and RMI	√	√
	– Doppler VOR	√	√
3.4	DISTANCE MEASURING EQUIPMENT (DME)	√	√
	– principles	√	√
	– frequencies	√	√
	– presentation and interpretation	√	√
	– range and coverage	√	√
	– factors affecting range and accuracy	√	√
	– Precision DME (DME/P)	√	√
3.5	INSTRUMENT LANDING SYSTEM (ILS)	√	√
	– principles	√	√
	– frequencies	√	√
	– presentation and interpretation	√	√
	– range and coverage	√	√

REF		A	H
	– errors and accuracy	√	√
	– factors affecting range and accuracy	√	√
3.6	MICROWAVE LANDING SYSTEM (MLS)	√	√
	– principles	√	√
	– frequencies	√	√
	– presentation and interpretation	√	√
	– range and coverage	√	√
	– errors and accuracy	√	√
	– factors affecting range and accuracy	√	√
3.7	BASIC RADAR PRINCIPLES	√	√
	– pulse techniques and associated terms	√	√
3.8	GROUND RADAR	√	√
	– principles	√	√
	– presentation and interpretation	√	√
	– coverage	√	√
	– range	√	√
	– errors and accuracy	√	√
	– factors affecting range and accuracy	√	√
3.9	AIRBORNE WEATHER RADAR	√	√
	– principles	√	√
	– presentation and interpretation	√	√
	– coverage	√	√
	– range	√	√
	– errors and accuracy	√	√
	– factors affecting range and accuracy	√	√
	– application for navigation	√	√
3.10	SECONDARY SURVEILLANCE RADAR (SSR)	√	√
	– principles	√	√

REF		A	H
	– presentation and interpretation	√	√
	– modes and codes, including mode S	√	√
3.11	RADIO ALTIMETER	√	√
	– principles	√	√
	– frequency band	√	√
	– presentation and interpretation	√	√
	– errors and accuracy	√	√
3.12	GROUND PROXIMITY WARNING SYSTEM (GPWS)	√	√
	– principles	√	√
	– warning modes	√	√
3.13	TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS)	√	√
	– principles of operation	√	√
	– warning modes	√	√
3.14	DOPPLER	√	√
	– principles of operation	√	√
	– ground speed and drift calculation	√	√
	– accuracy and reliability	√	√
	– flight deck equipment	√	√
3.15	EMERGENCY LOCATOR TRANSMITTER (ELT)	√	√
	– principles	√	√
	– frequencies	√	√
	– testing	√	√
3.16	AREA NAVIGATION	√	√
	VOR/DME area navigation (RNAV)	√	√
	– principle of operation	√	√
	– advantages and disadvantages	√	√
	– accuracy, reliability and coverage	√	√
	- use and limitations	√	√

	– flight deck equipment	√	√
REF		**A**	**H**
3.17	SATELLITE ASSISTED NAVIGATION: (GPS/GNSS)	√	√
3.17.1	Global Positioning Service (GPS)	√	√
	– system capability	√	√
3.17.1.1	The GPS system	√	√
	– segments	√	√
	– timing	√	√
	– frequency and coding	√	√
	– operating principles	√	√
	– limitations	√	√
	– coverage	√	√
	– reliability/integrity	√	√
	– accuracy and errors	√	√
	– dilution of precision	√	√
	– System Components and principle of operation	√	√
	– advantages and disadvantages	√	√
	- Navigation System Performance Requirements	√	√
	- Authorisation and Documentation	√	√
	- Errors and Limitations	√	√
	- Human Factors and GNSS	√	√
3.17.2	Differential GPS (DGPS)	√	√
	– principle of operation	√	√
	– pseudolite/GPS	√	√
3.17.3	GLONASS	√	√
	– basic concepts	√	√

REF	3. NAVIGATION	A	H
4.1	THE EARTH	√	√
4.1.1	FORM OF THE EARTH	√	√
	– polar axis, direction and rate of rotation	√	√
	– great circles, small circles and rhumb lines	√	√
	– meridians of longitude, limits east/west, prime meridian	√	√
	– difference of longitude	√	√
	– convergency and conversion angle	√	√
	– latitude, limits north/south, equator	√	√
	– difference of latitude	√	√
	– use of co-ordinates to fix position	√	√
4.1.2	DIRECTION	√	√
	– true north	√	√
	– magnetic north	√	√
	– isogonals and variation east and west	√	√
	– compass north	√	√
	– application of compass deviation	√	√
	– radio bearings: QTE, QDR, QDM, QUJ	√	√
4.1.3	DISTANCE	√	√
	– units of distance: nautical and statute miles, kilometres	√	√
	– metres, feet	√	√
	– conversion from one unit to another	√	√
	– relationship between nautical miles and minutes of latitude	√	√
4.2	THE SOLAR SYSTEM AND TIME	√	√
4.2.1	– seasonal and apparent movements of the sun	√	√
	– apparent solar day	√	√
	– mean solar day	√	√
	– sidereal day	√	√
4.2.2	– Equinox, solstice, aphelion, perihelion	√	√

REF		A	H
	– Tropics of Cancer and Capricorn	√	√
4.2.3	– Local mean time (LMT), zone time and standard time	√	√
	– conversions of arc to time	√	√
	– co-ordinated universal time (UTC)	√	√
	– time conversions	√	√
	– international date line	√	√
4.2.4	– determination of sunrise, sunset, civil twilight	√	√
	– variation of time with sunrise, sunset, latitude and altitude	√	√
	– sunrise and sunset along track	√	√
	– moonrise and moonset	√	√
4.3	CHARTS	√	√
4.3.1	Chart projection theory	√	√
	– types of projection: Azimuthal/Plane, cylindrical, conical	√	√
	– orthomorphic/conformal charts	√	√
	– scale, representative fraction, scale factor and calculations	√	√
4.3.2	Mercator chart	√	√
4.3.2.1	Method of construction and properties	√	√
	– representation of great circle, rhumb lines, meridians and parallels of latitude	√	√
	– plotting radio bearings	√	√
	– scale variation and calculations	√	√
	– measurement or calculation or tracks and distance	√	√
4.3.2.2	Meridional parts	√	√
4.3.2.3	Transverse Mercator	√	√
	– method of construction	√	√
	– properties	√	√
4.3.3	Lamberts Conformal Conic	√	√
	– method of construction and properties	√	√

REF		A	H
	– representation of great circle, rhumb lines, meridians and parallels of latitude	√	√
	– plotting radio bearings	√	√
	– scale variation and calculations	√	√
	– measurement or calculation or tracks and distance	√	√
4.3.4	Polar Stereographic	√	√
	– method of construction and properties	√	√
	– representation of great circle, rhumb lines, meridians and parallels of latitude	√	√
	– plotting radio bearings	√	√
	– scale variation and calculations	√	√
	– measurement or calculation or tracks and distance	√	√
4.3.5	Grid Navigation	√	√
	– use on polar stereographic chart	√	√
	– grid north, isogrivs, grivation	√	√
	– calculation of true, magnetic and grid headings or tracks	√	√
4.4	Relative Velocity	√	√
	– speed of opening and closing	√	√
	– aircraft separation	√	√
	– controlled time of arrival by changing speed	√	√

REF	4. INSTRUMENTS AND ELECTRONICS	A	H
5.1	AIR DATA INSTRUMENTS	√	√
5.1.1	PITOT AND STATIC SYSTEM	√	√
	– pitot tube, construction and principles of operation	√	√
	– static source	√	√
	– malfunction	√	√
	– heating	√	√
	– alternate static source	√	√
5.1.2	ALTIMETER	√	√
	– construction and principles of operation	√	√
	– simple, sensitive and servo assisted altimeters	√	√
	– errors and tolerances	√	√
	– settings, QNH, QFE, QNE	√	√
	– pressure, true and absolute altitude	√	√
	– altitude alert	√	√
5.1.3	AIRSPEED INDICATOR (ASI)	√	√
	– construction and principles of operation	√	√
	– meaning of coloured sectors	√	√
	– maximum speed indicator	√	√
	– errors, blockages and leaks	√	√
5.1.4	MACHMETER	√	√
	– Mach number formula	√	**n / a**
	– construction and principles of operation	√	**n / a**
	– display	√	**n / a**
	– errors, blockages and leaks	√	**n / a**
	– calculations	√	**n / a**
5.1.5	VERTICAL SPEED INDICATOR (VSI)	√	√
	– construction and principles of operation	√	√
	– aneroid and instantaneous VSI (IVSI)	√	√

REF		A	H
	– errors	√	√
5.1.6	AIR DATA COMPUTER (ADC)	√	√
	– principle of operation	√	√
	– input and output data, signals	√	√
	– uses of output data	√	√
5.2	GYROSCOPIC INSTRUMENTS	√	√
5.2.1	GYROSCOPIC FUNDAMENTALS	√	√
	– theory of gyroscopic forces (stability, precession)	√	√
	– types, construction and principles of operation:	√	√
	– vertical gyro	√	√
	– rate gyro	√	√
	– tied gyro	√	√
	– apparent wander/drift	√	√
	– real wander/drift	√	√
	– mountings, gimbals	√	√
	– drive types: electrical, vacuum system	√	√
5.2.2	DIRECTIONAL GYRO (DG)	√	√
	– construction	√	√
	– principle of operation	√	√
	– limitations	√	√
	– calculation of drift	√	√
5.2.3	REMOTE INDICATING COMPASS	√	√
	– construction and principle of operation	√	√
	– components	√	√
	– modes of operation	√	√
	– application, uses of output data	√	√
5.2.4	ARTIFICIAL HORIZON (AH)	√	√
	– construction and principle of operation	√	√

REF		A	H
	– turn and acceleration errors	√	√
	– application, uses of output data	√	√
5.2.5	TURN AND SLIP INDICATOR	√	√
	– construction and principle of operation	√	√
	– errors	√	√
	– Turn Co-ordinator	√	√
	– rate of turn and angle of bank	√	√
5.3	INERTIAL NAVIGATION SYSTEM (INS)	√	**n/a**
5.3.1	Principles and practical application	√	**n/a**
	– gyroscopic principles	√	**n/a**
	– platform mounting	√	**n/a**
	– accelerometer principles	√	**n/a**
	– integrator principles	√	**n/a**
	– Shuler-tuned platform	√	**n/a**
	– navigation computer	√	**n/a**
5.3.2	Alignment procedures	√	**n/a**
	– gyro compassing	√	**n/a**
	– levelling	√	**n/a**
5.3.3	Accuracy, reliability, errors and coverage	√	**n/a**
5.3.4	Flight deck equipment and operation	√	**n/a**
	– mode selector unit (MSU)	√	**n/a**
	– control display unit (CDU)	√	**n/a**
	– horizontal situation indicator (HSI)	√	**n/a**
5.3.5	INS Operation	√	**n/a**
	– normal flight, position and waypoint entries	√	**n/a**
	– flight plan changes	√	**n/a**
	– bypassing waypoint	√	**n/a**
	– change of waypoint data	√	**n/a**

REF		A	H
	– system check and updating	√	**n/a**
5.4	INERTIAL REFERENCE SYSTEM (IRS)	√	**n/a**
	– ring laser gyro	√	**n/a**
	– strap-down systems	√	**n/a**
	– platform alignment	√	**n/a**
	– limitations and accuracy	√	**n/a**
	– advantages	√	**n/a**
5.5	ELECTRONIC FLIGHT INSTRUMENT SYSTEM (EFIS)	√	**n/a**
	– information display types	√	√
	– data input	√	√
	– control panel, display unit	√	√
	– typical aircraft installation	√	√
5.6	FLIGHT MANAGEMENT SYSTEM (FMS)	√	√
	– general principles	√	√
	– inputs and outputs of data	√	√
5.7	FLIGHT DIRECTOR SYSTEM	√	√
	– principle of operation	√	√
	– input sources	√	√
	– operation of attitude director indicator (ADI)	√	√
	– operation of horizontal situation indicator (HSI)	√	√
5.8	AUTOPILOT	√	√
5.8.1	General principles of operation	√	√
	– types: single axis, two axis, three axis	√	√
	– lateral modes (pitch)	√	√
	– longitudinal modes (roll)	√	√
	– combined modes (roll and pitch)	√	√
5.8.2	Yaw damper	√	**n/a**
	– function	√	**n/a**

REF		A	H
	– components	√	**n / a**
	– principle of operation	√	**n / a**
5.8.3	Automatic pitch trim	**√**	**√**
	– function	√	**n / a**
	– input data, signals	√	**n / a**
	– mode of operation	√	**n / a**
	– horizontal stabiliser, trim tab actuator	√	**n / a**
	– system monitoring, safety of operation	√	**n / a**
5.9	WARNING AND RECORDING EQUIPMENT	**√**	**√**
5.9.1	Stall warning	√	**n / a**
	– components and principle of operation	√	**n / a**
5.9.2	Flight data recorder	√	√
	– function	√	√
	– components	√	√
	– operation	√	√
	– system monitoring	√	√
5.9.3	Cockpit voice recorder	√	√
	– function	√	√
	– components	√	√
	– operation	√	√
5.9.4	Rotors and engine over/under-speed warning	**n / a**	**√**
	– function	**n / a**	√
	– input data, signals	**n / a**	√
	– display, indicators, function test	**n / a**	√
	– effects on operation in case of failure	**n / a**	√
5.10	POWERPLANT AND SYSTEM MONITORING INSTRUMENTS	√	√
5.10.1	Principles, presentation and operational use of:	√	√
	– pressure and temperature sensors	√	√

REF		A	H
	– pressure and temperature indicators	√	√
	– RPM indicator, piston and turbine engines	√	√
	– fuel gauge and fuel flow indicators	√	√
	– Torque meter	√	√
	– Vibration monitors	√	√
	– Chip detection	**n / a**	√
5.10.2	Air temperature indictors	√	√
	– sensors	√	√
	– ram rise, recovery factor	√	**n / a**
	– SAT, RAT AND TAT	√	**n / a**
5.11	MAGNETISM	√	√
5.11.1	TERRESTRIAL MAGNETISM	√	√
	– resolution of the earth's magnetic field into vertical and horizontal components	√	√
	– the effects of change of latitude on these components	√	√
	– directive force, isodynes	√	√
	– magnetic dip, isoclinals	√	√
	– variation, isogonals, agonic line	√	√
	– changes of the earth's magnetic field, secular, periodic	√	√
5.11.2	AIRCRAFT MAGNETISM	√	√
	– horizontal hard iron, components P and Q	√	√
	– vertical soft iron	√	√
	– compass swing, calculation of coefficients A, B and C	√	√
	– correction of coefficients A, B and C	√	√
	– deviation on any heading	√	√
	– change of deviation with change of latitude and aircraft heading	√	√
	– turning and acceleration errors	√	√

REF		A	H
5.11.3	MAGNETIC COMPASS	√	√
	– components and principle of operation	√	√
	– serviceability tests	√	√
	– adjustment and compensation of direct reading compass	√	√

REF	6.1 AIRCRAFT TECHNICAL AND GENERAL– *AEROPLANE*	A
6.1.1	AIRFRAME AND SYSTEMS	√
6.1.1.1	Fuselage	√
	– types of construction	√
	– structural components and materials used	√
	– stress	√
6.1.1.2	Cockpit and passenger cabin windows	√
	– construction – laminated glass, acrylic plastic	√
	– structural limitations	√
6.1.1.3	Wings and stabilising surfaces	√
	– types of construction	√
	– structural components and materials used	√
	– stress relief of engines	√
6.1.1.4	Landing gear	√
	– types	√
	– construction	√
	– locking devices and emergency extension systems	√
	– accidental retraction prevention devices	√
	– position, movement lights and indicators	√
	– nosewheel steering	√
	– wheels and tyres (construction, markings, limitations)	√
	– braking systems	√
	– construction, single and multi-plate disc brakes	√
	– parking brake	√
	– operation of anti-skid system	√
	– operation of auto brake system	√
	– indications and warning systems	√

REF		A
6.1.1.5	Hydraulics	√
6.1.1.5.1	Basic principles of hydromechanics	√
	– hydraulic fluids	√
	– components and operation of basic hydraulic system	√
6.1.1.5.2	Hydraulic systems	√
	– main, standby and emergency systems	√
	– operation, indicators and warning systems	√
	– ancillary systems	√
6.1.1.6	Air driven systems	√
6.1.1.6.1	Pneumatic systems	√
	– power sources	√
	– components, construction and operation of basic system	√
	– potential failures, warning devices, indicators	√
6.1.1.6.2	Air conditioning system	√
	– heating and cooling	√
	– construction, functioning and controls	√
	– warning devices	√
6.1.1.6.3	Pressurisation	√
	– cabin altitude, maximum cabin altitude	√
	– differential pressure	√
	– pressurised zones in the aircraft	√
	– operation and indicators	√
	– safety devices and warning systems	√
	– rapid decompression, cabin altitude warning	√
	– emergency procedures	√
6.1.1.6.4	De-ice systems	√
	– pneumatic leading edge de-icing of wings/control surfaces	√
	– components, construction and operation	√

REF		A
	– use and operational limitations	√
6.1.1.6.5	Anti-ice systems	√
	– aerofoil, control surfaces, powerplant, air intakes, windshield	√
	– components, construction and operation	√
	– use and operational limitations	√
	– ice warning system	√
6.1.1.7	Non-pneumatic operated de-ice and anti-ice systems	√
6.1.7.1	Components, construction and operation of:	√
	– air intake	√
	– pitot, static pressure sensor and stall warning devices	√
	– windshield	√
	– weeping wing system	√
	– rain repellent system	√
6.1.7.2	Fuel dumping system	√
6.1.7.3	Fuel system monitoring	√
	– operation, indicators, warning systems	√
6.1.1.8	ELECTRICS	√
6.1.1.8.1	Direct Current (DC)	√
6.1.1.8.2	DC Generator	√
	– principle of operation	√
6.1.1.8.3	Current distribution	√
	– DC bus bars	√
	– ammeter and voltmeter	√
	– annunciators	√
	– inverter	√
6.1.1.8.4	Alternating current	√
	– single and multi-phase AC	√

REF		A
	– frequency	√
	– phase shift	√
	– AC components	√
6.1.1.8.5	Alternators	√
	– 3 phase	√
	– brushless: construction and operation	√
	– constant speed and integrated drives	√
6.1.1.8.6	AC power distribution	√
	– construction, operation and monitoring	√
	– protection circuits, paralleling of AC generators	√
	– AC bus bars	√
6.1.1.8.7	Transformers	√
	– function, types and applications	√
6.1.1.8.8	Transformer/rectifier units	√
6.1.2	POWERPLANT	√
	Turbine engine	√
6.1.2.1	Principle of operation	√
6.1.2.2	Types of construction	√
	– centrifugal	√
	– axial flow	√
6.1.2.3	Engine construction	√
6.1.2.3.1	Air inlet	√
	– function	√
6.1.2.3.2	Compressor	√
	– function	√
	– construction and mode of operation	√
	– effects of damage	√
	– compressor stall and surge (cause, recognition, avoidance)	√

REF		A
	– compressor characteristics	√
6.1.2.3.3	Combustion chamber	√
	– function	√
	– mixing ratios	√
	– fuel injectors	√
	– thermal load	√
6.1.2.3.4	Turbine	√
	– function, construction and working principles	√
	– thermal and mechanical stress	√
	– effects of damage	√
	– monitoring of exhaust gas temperature	√
6.1.2.3.5	Jet pipe	√
	– function	√
	– different types	√
	– noise silencing devices	√
6.1.2.3.6	Pressure, temperature and airflow in a turbine engine	√
6.1.2.3.7	Reverse thrust	√
	– function, type and principles of operation	√
	– degree of efficiency	√
	– use and monitoring	√
6.1.2.3.8	Performance and thrust augmentation	√
	– water injection, principles of operation	√
	– use and system monitoring	√
6.1.2.3.9	Bleed air	√
	– effect of use of bleed air on thrust, exhaust gas temperature	√
	RPM and pressure ratio	√
	– effect of use of bleed air on performance	√
6.1.2.3.10	Auxiliary gearbox	√

REF		A
	– function	√
6.1.2.4	Turbine engine systems	√
6.1.2.4.1	Ignition	√
	– function, types, components, operation, safety aspects	√
6.1.2.4.2	Starter	√
	– function, type, construction and mode of operation	√
	– control and monitoring	√
	– self-sustaining and idle speeds	√
6.1.2.4.3	Engine start malfunctions	√
	– types, cause and avoidance	√
6.1.2.4.4	Fuel system	√
	– construction and components	√
	– operation and monitoring	√
	– malfunctions	√
6.1.2.4.5	Lubrication	√
	– construction and components	√
	– operation and monitoring	√
	– malfunctions	√
6.1.2.4.6	Fuel	√
	– effects of temperature	√
	– impurities and additives	√
6.1.2.4.7	Thrust	√
	– thrust formula	√
	– flat rated engine	√
	– thrust as a function of airspeed, air density, pressure, temperature and RPM	√
6.1.2.4.8	Engine operating and monitoring	√
6.1.2.5	Auxiliary Power Unit (APU)	√

REF		A
	– function, types	√
	– location	√
	– operation and monitoring	√
6.1.2.6	Ram air turbine	√
	– function	√
6.1.3	Emergency equipment	√
6.1.3.1	Smoke detection	√
	– location, indicators, function test	√
6.1.3.2	Fire detection and fire fighting	√
	– location, warning mode, function test	√
6.1.3.3	Oxygen systems	√
	– types of systems, principles of operation	√
	– use and safety measures	√
6.1.4	Special Operational Procedures and Hazards	√
6.1.4.1	Ground de-icing	√
	– icing conditions	√
	– de-icing, ant-icing, types of fluids	√
6.1.4.2	Bird strike risk and avoidance	√
6.1.4.3	Noise abatement	√
	– influence of the flight procedure (departure, cruise or	√
	approach)	√
	– influence by the pilot (power setting, low drag/power)	√
6.1.4.4	Fire/Smoke	√
	– engine fire	√
	– fire in the cabin, cockpit, freight compartment	√
	– selection of appropriate fire extinguishing agents with respect to fire classification	√

REF		A
	– actions in case of over-heated brakes after aborted take-off and landing	√
	– smoke in the cockpit and cabin (effects and actions taken)	√
6.1.4.5	Windshear, microburst	√
	– effects and recognition during approach/departure	√
	– actions to avoid and actions taken during encounter	√
6.1.4.6	Wake turbulence	√
	– cause	√
	– influence of speed and mass, wind	√
	– actions taken during approach, landing, take-off, crossing behind	√
6.1.4.7	Contaminated runways	√
	– types of contamination	√
	– aquaplaning: types and avoidance	√
	– braking action and braking coefficient	√
6.1.5	SUBSONIC AERODYNAMICS	√
6.1.5.1	Laws and definitions	√
	– units of measurement	√
	– Newton's Laws of Motion	√
	– velocity	√
	– temperature and density	√
	– static and dynamic pressure	√
	– momentum	√
	– acceleration	√
	– equilibrium	√
6.1.5.2	Airspeeds	√
	– Indicated Airspeed (IAS)	√
	– Calibrated Airspeed (CAS)	√

REF		A
	– Equivalent Airspeed (EAS)	√
	– True Airspeed (TAS)	√
	– Mach number	√
6.1.5.3	Shape of an aerofoil	√
	– taper ratio	√
	– root chord, tip chord and mean aerodynamic chord	√
	– aspect ratio, angle of sweepback	√
	– high speed aerofoils	√
6.1.5.4	Controls	√
	Method of operation of:	√
	– basic elevator, ailerons, rudder and combinations	√
	– inboard ailerons, flaperons, roll control spoilers	√
	– combined aileron and spoiler controls	√
	– speed brakes, ground spoilers	√
	– variable elevator	√
	– indicators and warning devices	√
	– mode of actuation: mechanical, hydraulic, fly by wire	√
	– artificial feel	√
	– indicators, warning devices	√
6.1.5.5	Trimming control systems	√
	– fixed tabs, balance tab, anti-balance tab, servo tab	√
	– spring tab	√
	– variable incidence tailplane	√
6.1.5.6	High lift devices	√
6.1.5.6.1	Trailing edge flaps	√
	– slotted and multiple slotted flaps	√
	– the Fowler flap and slotted Fowler flap	√

REF		A
6.1.5.6.2	Leading edge devices	√
	– Krueger flap	√
	– slats and slots, automatic slots	√
6.1.6	HIGH SPEED FLIGHT	√
6.1.6.1	Flight speed classification	√
	– subsonic	√
	– Transonic	√
	– Supersonic	√
6.1.6.2	Speed of sound	√
	– Mach number and formula	√
	– effect of temperature and altitude	√
	– compressibility	√
	– free stream Mach number	√
	– local Mach number	√
6.1.6.3	Shockwaves	√
	– propagation of pressure waves	√
	– normal shockwave	√
	– critical Mach number	√
	– accelerating beyond Mcrit	√
	– influence of:	√
	– Mach number	√
	– control deflection	√
	– angle of attack	√
	– aerofoil thickness	√
	– angle of sweep	√
	– area rule	√
	– influence on:	√
	– CL and CD	√

REF		A
	– aerodynamic heating	√
	– shock stall/Mach buffet	√
	– influence on:	√
	– drag	√
	– pitch (Mach trim)	√
	– contribution of:	√
	– movement of centre of pressure	√
	– angle of sweep	√
	– downwash	√
	– methods of reducing/delaying transonic drag rise	√
	– control problems in transonic flight	√
6.1.6.4	SUPERSONIC AERODYNAMICS	√
	– oblique shockwaves	√
	– Mach cone	√
	– influence of aircraft weight	√
	– expansion waves	√
	– centre of pressure	√
	– wave drag	√
	– control surface hinge movement	√
	– control surface efficiency	√

REF	6.2 AIRCRAFT TECHNICAL AND GENERAL – *HELICOPTER*	H
6.2.1	AIRFRAME AND SYSTEMS	√
6.2.1.1	Helicopter configurations	√
	– single rotor	√
	– tandem rotor	√
	– coaxial rotor	√
	– side by side rotor	√
6.2.1.2	Controls and rotors	√
	Control systems	√
	– types, components, adjustments	√
	– primary controls (cyclic, collective, directional)	√
6.2.1.3	Rotorheads	√
	– types, components, operation	√
6.2.1.4	Tail rotors/Notar	√
	– types, components, operation	√
6.2.1.5	Blades	√
	– types, construction, material, adjustment, balancing	√
6.2.1.6	Control surfaces	√
	– vertical and horizontal stabilisers, construction, material	√
6.2.1.7	Fuselage	√
	– types of construction	√
	– structural components and materials	√
6.2.1.8	Cockpit and cabin windows	√
	– construction	√
	– structural limitations	√
6.2.1.9	Landing gear	√
	– types: floats, skids, wheels	√

REF		H
	– construction	√
	– locking devices and emergency extension systems	√
	– accidental retraction prevention devices	√
	– position, movement lights and indicators	√
	– wheels and tyres (construction, markings, limitations)	√
	– braking systems	√
	– construction	√
	– parking brake	√
	– operation, indications and warning systems	√
6.2.1.10	Transmission systems	√
6.2.1.10.1	Drive shafts	√
	– types, components, materials	√
6.2.1.10.2	Gearboxes	√
	– types, construction, material, lubrication, indications	√
6.2.1.10.3	Clutches	√
	– types, components	√
6.2.1.10.4	Freewheeling	√
	– types, components	√
6.2.1.10.5	Rotor brake	√
	– components, construction	√
6.2.1.10.6	Inspection	√
	– vibration, balancing, tracking	√
6.2.1.11	Hydraulics	√
6.2.1.11.1	Basic principles of hydromechanics	√
	– hydraulic fluids	√
	– components and operation of basic hydraulic system	√
6.2.1.11.2	Hydraulic systems	√
	– main, standby and emergency systems	√

REF		H
	– operation, indicators and warning systems	√
	– ancillary systems	√
	– auxiliary systems	√
6.2.1.12	Air driven systems	√
6.2.1.12.1	Pneumatic systems	√
	– power sources	√
	– components, construction and operation of basic system	√
	– potential failures, warning devices, indicators	√
6.2.1.12.2	Air conditioning system	√
	– heating and cooling	√
	– construction, functioning and controls	√
	– warning devices	√
	– ram air ventilation	√
6.2.1.13	De-ice and anti-ice systems	√
	– components, construction and operation of:	√
	– air intake, rotors (main and tail rotor)	√
	– pitot, static pressure sensor	√
	– windshield	√
	– control surfaces	√
	– rain repellent systems	√
	– ice warning system	√
6.2.1.14	Fuel dumping system	√
6.2.1.15	Fuel system monitoring	√
	– operation, indicators, warning systems	√
6.2.1.16	ELECTRICS	√
6.2.1.16.1	Direct current	√
6.2.1.16.2	DC Generator	√
	– principle of operation	√

REF		H
6.2.1.16.3	Current distribution	√
	– DC bus bars	√
	– ammeter and voltmeter	√
	– annunciators	√
	– inverter	√
6.2.1.16.4	Alternating current	√
	– single and multi-phase AC	√
	– frequency	√
	– phase shift	√
	– AC components	√
6.2.1.16.5	Alternators	√
	– 3 phase	√
	– brushless: construction and operation	√
	– constant speed and integrated drives	√
6.2.1.16.6	AC power distribution	√
	– construction, operation and monitoring	√
	– protection circuits, paralleling of AC generators	√
	– AC bus bars	√
6.2.1.16.7	Transformers	√
	– function, types and applications	√
6.2.1.16.8	Transformer/rectifier units	√
6.2.2	Turbine engine	√
6.2.2.1	Principle of operation	√
6.2.2.2	Types of construction	√
	– centrifugal	√
	– axial flow	√
6.2.2.3	Engine construction	√
6.2.2.3.1	Air inlet	√

REF		H
	– function	√
6.2.2.3.2	Compressor	√
	– function	√
	– construction and mode of operation	√
	– effects of damage	√
	– compressor stall and surge (cause, recognition, avoidance)	√
	– compressor characteristics	√
6.2.2.3.3	Combustion chamber	√
	– function	√
	– mixing ratios	√
	– fuel injectors	√
	– thermal load	√
6.2.2.3.4	Turbine	√
	– function, construction and working principles	√
	– thermal and mechanical stress	√
	– effects of damage	√
	– monitoring of exhaust gas temperature	√
6.2.2.3.5	Pressure, temperature and airflow in a turbine engine	√
6.2.2.4	Turbine engine systems	√
6.2.2.4.1	Ignition	√
	– function, types, components, operation, safety aspects	√
6.2.2.4.2	Starter	√
	– function, type, construction and mode of operation	√
	– control and monitoring	√
	– self-sustaining and idle speeds	√
6.2.2.4.3	Engine start malfunctions	√
	– cause and avoidance	√
6.2.2.4.4	Fuel system	√

REF		H
	– construction and components	√
	– operation and monitoring	√
	– malfunctions	√
6.2.2.4.5	Lubrication	√
	– construction and components	√
	– operation and monitoring	√
	– malfunctions	√
6.2.2.4.6	Fuel	√
	– effects of temperature	√
	– impurities and additives	√
6.2.2.4.7	Engine operating and monitoring	√
6.2.3	Emergency equipment	√
6.2.3.1	Smoke detection	√
	– location, indicators, function test	√
6.2.3.2	Fire detection and fire fighting	√
	– location, warning mode, function test	√
6.2.3.3	Oxygen systems	√
	– types of systems, principles of operation	√
	– use and safety measures	√
6.2.4	Special Operational Procedures and Hazards	√
6.2.4.1	Ground de-icing	√
	– icing conditions	√
	– de-icing, ant-icing, types of fluids	√
6.2.4.2	Bird strike risk and avoidance	√
6.2.4.3	Noise abatement	√
	– influence of the flight procedure (departure, cruise or approach)	√
	– influence by the pilot (power setting, track of helicopter)	√

REF		H
6.2.4.4	Fire/Smoke	√
	– carburettor fire	√
	– engine fire	√
	– fire in the cabin, cockpit, freight compartment	√
	– selection of appropriate fire extinguishing agents with respect to fire classification	√
	– smoke in the cockpit and cabin (effects and actions taken)	√
6.2.4.5	Windshear, microburst	√
	– effects and recognition during approach/departure	√
	– actions to avoid and actions taken during encounter	√
6.2.4.6	Wake turbulence	√
	– cause	√
	– influence of speed and mass, wind	√
	– actions taken during approach, landing, take-off, crossing behind	√
6.2.4.7	Contaminated runways	√
	– types of contamination	√
	– braking action and braking coefficient	√
6.2.4.8	Rotor downwash	√
6.2.4.9	Emergency procedures	√
	– influence by technical problems:	√
	– engine failure	√
	– tail rotor/directional control failure	√
	– ground/resonance	√
	– blade/stall	√
	– settling with power	√
	– overpitch	√
	– overspeed	√

REF		H
	– sudden stoppage	√
	– dynamic rollover/mast bumping	√
6.2.5	SUBSONIC AERODYNAMICS	√
6.2.5.1	Laws and definitions	√
	– units of measurement	√
	– Newton's Laws of Motion	√
	– mass and weight	√
	– inertia	√
	– velocity	√
	– temperature and density	√
	– static and dynamic pressure	√
	– momentum	√
	– acceleration	√
	– equilibrium	√
	– motion on a curved path	√
	– work, power and energy	√
	Airspeeds	√
	– Indicated Airspeed (IAS)	√
	– Calibrated Airspeed (CAS)	√
	– Equivalent Airspeed (EAS)	√
	– True Airspeed (TAS)	√
6.2.5.2	Lift	√
	– equation of continuity	√
	– Bernoulli's theorem and the venturi effect	√
6.2.5.2.1	Aerofoil definitions	√
	– relative airflow	√
	– camber and mean camber line	√
	– chord line	√

REF		H
	– angle of attack	√
	– centre of pressure	√
	– pressure distribution around an aerofoil	√
	– lift formula and lift curve	√
	– lift/drag ratio	√
6.2.5.2.2	Shape of an aerofoil	√
	– symmetrical aerofoils	√
	– aspect ratio	√
6.2.5.3	Drag	√
6.2.5.3.1	Profile drag	√
	– form drag	√
	– skin friction	√
	– causes, variation with speed, methods of minimising	√
6.2.5.3.2	Induced drag	√
	– causes, vortices, variation with speed/angle of attack	√
	– design methods used to minimise	√
6.2.5.3.3	Drag formula	√
6.2.5.3.4	Drag curves, total drag curve and factors affecting	√
6.2.5.4	Distribution of forces – balance of couples	√
	– lift/weight and thrust/drag couples	√
	– methods of achieving balance	√
6.2.5.5	Stability	√
	– helicopter axes and planes of rotation	√
	– static stability	√
	– dynamic stability	√
	– longitudinal stability	√
	– lateral stability	√
	– directional stability	√

REF		H
	– effects of design features on stability	√
6.2.5.6	Blade stall	√
	– stalling angle of attack	√
	– boundary layer flow	√
	– variation of lift and drag at the stall	√
6.2.5.7	Transonic effects on blades	√
	– shock waves	√
	– formation and effect on helicopter handling	√
6.2.6	HELICOPTER AERODYNAMICS	√
6.2.6.1	Definitions	√
	– axis of rotation	√
	– rotor shaft axis	√
	– tip path	√
	– tip path plane	√
	– rotor disc	√
	– disc loading	√
	– blade loading	√
6.2.6.2	The forces diagram and associated terminology	√
	– pitch angle (blade angle)	√
	– rotational airflow	√
	– induced airflow	√
	– lift blade	√
	– drag blade	√
	– total reaction – blade	√
	– rotor thrust	√
	– rotor drag	√
	– torque	√
6.2.6.3	Uniformity of rotor thrust along the blade	√

REF		H
	– blade twist	√
	– taper	√
	– coning angle	√
	– centrifugal force	√
	– limits of rotor RPM	√
	– centrifugal turning moments	√
6.2.6.4	Helicopter controls	√
6.2.6.4.1	Collective lever	√
	– collective pitch changes	√
	– relationship with rotor thrust and rotor drag	√
6.2.6.4.2	Cyclic stick	√
	– cyclic pitch changes	√
	– rotor disc attitude	√
	– rotor thrust tilt	√
6.2.6.4.3	Yaw pedals	√
	– fuselage torque	√
	– tail rotor drift	√
	– tail rotor roll	√
	– fenestron tail	√
	– notar	√
6.2.6.5	Rotor blade freedom of movement	√
	– the feathering hinge	√
	– pitch angle	√
6.2.6.6	Flapping	√
	– the flapping hinge	√
	– flapping to equality	√
6.2.6.7	Dragging	√
	– the drag hinge	√

REF		H
	– drag dampers	√
	– leading/lagging	√
	– periodic drag changes	√
	– blade CG (conservation of angular momentum)	√
	– hookes joint effect	√
6.2.6.8	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	√
	– advantage angle – definition	√
6.2.6.9	Vertical flight	√
	– take-off	√
	– vertical climb	√
	– vertical descent	√
	– hover outside ground effect	√
	– ground effect	√
	– factors affecting ground cushion	√
	– avoidance of dynamic roll-over	√
6.2.6.10	Force in balance	√
	– at the hover	√
	– in forward flight	√
	– influence of CG	√
	– influence of rotor shaft tilt	√
6.2.6.11	Translational lift	√
	– effect of horizontal airflow on induce flow	√

REF		H
	– variation of total flow through the disc with forward flight	√
	– the relationship between pitch angle and angle of attack	√
6.2.6.12	Power requirements	√
	– rotor profile power	√
	– power absorption – tail rotor and ancillary equipment	√
	– rotor profile power variation with forward speed	√
	– induced drag	√
	– parasite drag	√
	– total power required	√
	– power available	√
6.2.6.13	Further aerodynamics of forward flight	√
	– transition to and from the hover	√
	– symmetry and asymmetry of rotor thrust	√
	– main rotor flapback	√
	– tail rotor flapback and methods of removal	√
	– factor affecting maximum forward speed	√
	– design limits of cyclic stick	√
	– airflow reversal	√
	– retreating blade stall	√
	– symptoms and recovery actions	√
	– compressibility	√
	– flow separation	√
	– shock stall	√
	– ‘G’ stall	√
	– inflow roll	√
6.2.6.14	Factors affecting cyclic stick limits	√
	– all up mass (AUM)	√
	– density altitude	√

REF		H
	– CG position	√
6.2.6.15	The flare – power flight	√
	– thrust reversal	√
	– effect on helicopter attitude	√
	– increase in rotor thrust	√
	– decrease in rotor drag	√
	– increase in rotor RPM	√
	– effect of deceleration	√
6.2.6.16	Settling with power (vortex ring)	√
	– tip vortices	√
	– comparison between induced flow and external flow	√
	– development	√
	– change in relative airflow along blade span	√
	– root stall and turbulence	√
6.2.6.17	Blade sailing	√
	– rotor RPM and blade rigidity	√
	– effect of adverse wind	√
	– minimising the danger	√
6.2.6.18	Autorotation – vertical	√
	– rate of descent airflow	√
	– effective airflow	√
	– relative airflow	√
	– inflow and outflow angle	√
	– autorotative force	√
	– rotor drag	√
	– effect of mass and altitude	√
	– control of rotor RPM	√

REF		H
	– rotor RPM stability	√
6.2.6.19	Autorotation – forward flight	√
	– factors affecting inflow angle	√
	– effect of forward speed on rate of descent	√
	– asymmetry 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 avoidance graph	√
6.2.6.20	Stability	√
	– hover	√
	– forward flight	√
	– rearward flight	√
	– stability aids	√
	– stabilisers and effects of CG	√
	– gyro controlled stabiliser system	√
	– stabiliser bars	√
	– delta hinge effect	√
	– effect of lever application on attitude in translational flight	√
6.2.6.21	Control power	√
	– the teetering head	√
	– fully articulated head	√
	– the rigid rotor	√

REF		H
	– effect on stability	√
	– effect on dynamic/static rollover	√
6.2.6.22	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	√
	– overpitch	√
	– overtorque	√
	– turning	√
	– comparison of piston and turbine engine helicopters	√
	– range and endurance	√
	– effect of density altitude	√
	– effect of aircraft weight	√