Appendix 2.B

COMBINED SYLLABUS OF THEORETICAL KNOWLEDGE FOR THE AIRLINE TRANSPORT PILOT LICENCE (AEROPLANE) AND (HELICOPTER)

REF	AVIATION METEOROLOGY	A	H
1.1	CLIMATOLOGY AND METEOROLOGY	√	√
	– Difference and definitions.	√	√
1.2	**THE ATMOSPHERE**	√	√
	– Properties, composition and structure.	√	√
	– The stratosphere and ozone.	√	n/a
	– ICAO International standard atmosphere (ISA).	√	√
	– ISA deviation.	√	√
1.3	**ATMOSPHERIC PRESSURE**	√	√
	– Definition.	√	√
	– Measurement and units in use. (Pa, hPa/mb/inches mercury/millimetres mercury)	√	√
	– Conversion between units	√	√
	– Mercury barometer.	√	√
	– Aneroid barometer.	√	√
	– Pressure altitude.	√	√
	– QNH, QFE, QFF and QNE/1013.25 hPa.	√	√
	– Pressure variation with height and diurnal variation.	√	√
	– Isobars.	√	√
	– Pressure gradient.	√	√
1.3.1	Low-pressure systems:	√	√
	– Characteristics and related terminology.	√	√
	– Thermal and lows.	√	√
	– Troughs.	√	√
	– Cut-off lows.	√	√
	– Typical cyclonic weather.	√	√
1.3.2	High-pressure systems:	√	√
	– Characteristics and related terminology.	√	√
	– Thermal highs.	√	√
	– Ridges.	√	√
	– Typical anti-cyclonic weather.	√	√
1.3.3	Cols and associated weather.	√	√
1.3.4	Synoptic charts.	√	√
1.4	**TEMPERATURE**	√	√
	– Measurement and units in use. (Celsius scale, Fahrenheit, Kelvin)	√	√
	– Conversion between units.	√	√
1.4.1	Heating of the atmosphere and heat transfer processes:	√	√
	– Insolation.	√	√
	– Radiation, conduction, convection.	√	√
	– Advection.	√	√

1.4.2	Diurnal variation of temperature.	√	√
1.4.3	Specific heat. Land and sea heating and cooling.	√	√
1.4.4	Atmospheric greenhouse effect.	√	√
1.5	**HUMIDITY**	√	√
1.5.1	Atmospheric water and changes of state:	√	√
	– Latent heat.	√	√
	– Evaporation, condensation, freezing, melting.	√	√
	– Sublimation and deposition.	√	√
1.5.2	Saturation, vapour pressure and dew point temperature.	√	√
1.5.3	Wet bulb and dry bulb temperatures. The psychrometer.	√	√
1.5.4	Atmospheric humidity and measurement of humidity:	√	√
	– Absolute humidity.	√	√
	– Relative humidity.	√	√
1.6	**DENSITY**	√	√
1.6.1	The gas laws and the compressibility of air.	√	√
	– Boyle's law.	√	√
	– Charles's law.	√	√
	– The ideal gas equation (Boyle's and Charles's laws).	√	√
1.6.2	Factors affecting density:	√	√
	– Temperature.	√	√
	– Pressure.	√	√
	– Altitude and latitude.	√	√
	– Humidity.	√	√
1.6.3	Density altitude:	√	√
	– Definition.	√	√
1.6.4	Calculating density altitude.	√	√
1.6.5	Effect of density altitude on aircraft performance.	√	√
1.6.6	The dangers of flight operations in hot, high and humid conditions.	√	√
1.7	**ALTIMETRY**	√	√
1.7.1	Variation of atmospheric pressure levels with changing pressure and temperature.	√	√
1.7.2	Calculations involving pressure and temperature corrections.	√	√
1.7.3	Calculating true altitude.	√	√
1.8	**WIND**	√	√
1.8.1	Definitions and terminology:	√	√
	– Veering and backing.	√	√
	– Gust, squall, lull, gale, hurricane, gust factor.	√	√
1.8.2	Measurement of wind:	√	√
	– Wind direction and speed.	√	√
	– Wind vane and anemometer.	√	√
1.8.3	Formation of wind:	√	√
	– Pressure gradient force.	√	√
	– Coriolis effect.	√	√
	– Geostrophic wind and Buys Ballot's law.	√	√
	– Gradient wind.	√	√

	– Surface wind.	√	√
	– Diurnal variation of wind.	√	√
1.8.4	Global circulation patterns:	√	√
	– General global pressure distribution.	√	√
	– General surface winds and circulation patterns (Trade winds, prevailing westerlies, polar easterlies).	√	√
	– Monsoon winds.	√	√
1.8.5	Local winds:	√	√
	– Land and Sea breezes.	√	√
	– Katabatic and anabatic winds.	√	√
	– The Bora.	√	√
	– The Mistral.	√	√
	– The North American blizzard.	√	√
	– The Föhn wind.	√	√
	– The Chinook.	√	√
	– The Zonda.	√	√
	– The Berg wind.	√	√
	– The Sirocco.	√	√
	– The Shamal.	√	√
	– The Haboob.	√	√
	– The Harmattan.	√	√
	– The Pampero.	√	√
1.8.6	Upper winds:	√	n/a
	– General global upper air circulation.	√	n/a
	– Thermal wind.	√	n/a
	– Jet stream winds.	√	n/a
	– Common jet stream winds (Sub-tropical and Polar front).	√	n/a
	– CAT (Clear air turbulence).	√	n/a
1.9	**LAPSE RATES, ADIABATIC PROCESSES, AND STABILITY**	√	√
1.9.1	Adiabatic processes.	√	√
1.9.2	Lapse rates:	√	√
	– Environmental lapse rate (ELR).	√	√
	– Dry adiabatic lapse rate (DALR).	√	√
	– Saturated adiabatic lapse rate (SALR).	√	√
1.9.3	Atmospheric stability:	√	√
	– Absolute stability.	√	√
	– Absolute instability.	√	√
	– Conditional instability.	√	√
	– Neutral stability.	√	√
1.9.4	Inversions.	√	√
1.9.5	Isothermal layers.	√	√
1.10	**CLOUDS**	√	√
1.10.1	Cloud observations and measurement:	√	√
	– Cloud amount.	√	√

	– Definitions of cloud ceiling and cloud base.	√	√
	– Methods of measuring cloud base and ceiling.	√	√
1.10.2	Cloud formation:	√	√
	– Convective.	√	√
	– Orographic.	√	√
	– Frontal.	√	√
	– Convergent.	√	√
	– Turbulent.	√	√
1.10.3	Cloud classification.	√	√
1.10.4	Cloud types.	√	√
1.11	**PRECIPITATION**	√	√
1.11.1	Condensation nuclei.	√	√
1.11.2	Precipitation processes:	√	√
	– Bergeron theory (ice particle theory).	√	√
	– Collision and coalescence theory.	√	√
1.11.3	Types of precipitation.	√	√
1.11.4	Intensity of precipitation.	√	√
1.11.5	Continuity of precipitation.	√	√
1.12	**THUNDERSTORMS**	√	√
1.12.1	Formation:	√	√
	– Conditions for development.	√	√
1.12.2	Thunderstorm classification:	√	√
	– Convective.	√	√
	– Orographic.	√	√
	– Convergent.	√	√
	– Frontal.	√	√
	– Nocturnal.	√	√
1.12.3	Additional classifications:	√	√
	– Ordinary and severe.	√	√
	– Line storms (squall lines).	√	√
1.12.4	The three stages of thunderstorm development.	√	√
1.12.5	The gust front and related phenomena.	√	√
1.12.6	Hazards:	√	√
	– Windshear and turbulence.	√	√
	– Microbursts.	√	√
	– Hail.	√	√
	– Icing.	√	√
	– Lightning	√	√
	– Tornadoes.	√	√
1.12.7	Avoidance and penetration.	√	√
1.13	**ICE ACCRETION**	√	√
1.13.1	Dangers.	√	√
1.13.2	Airframe icing:	√	√
	– Conditions for formation.	√	√
	– Kinetic heating formula.	√	n/a

	Types:	√	√
	– Clear (glaze) ice.	√	√
	– Rime ice.	√	√
	– Mixed ice.	√	√
	– Freezing precipitation and rain ice.	√	√
	– Hoar frost.	√	√
1.13.3	Engine icing:	√	√
	Piston engine icing.	√	√
	– Impact icing.	√	√
	– Fuel icing.	√	√
	– Carburettor icing: cause, recognition, prevention.	√	√
	Gas turbine engine icing.	√	√
1.13.4	Factors affecting the severity of icing.	√	√
1.13.5	ICAO definitions for levels of icing:	√	√
	– Light, moderate, severe.	√	√
1.13.6	Ice protection:	√	√
	– Anti-icing and de-icing.	√	√
1.15	**WINDSHEAR AND TURBULENCE**	√	√
1.15.1	Windshear:	√	√
	– Definition of windshear.	√	√
	– Causes.	√	√
	– Low-level windshear.	√	√
	– Effect on aircraft in flight.	√	√
	– Approach techniques.	√	√
1.15.2	Turbulence:	√	√
	– Definition of turbulence.	√	√
	– Types and causes.	√	√
1.15.3	Mountain waves and associated turbulence:	√	√
	– Conditions for formation and dangers.	√	√
	– Visual detection of mountain waves.	√	√
	– Dangers specific to high-altitude flight.	√	n/a
1.15.4	Wake turbulence:	√	√
	– Cause.	√	√
	– Dangers.	√	√
	– Conditions affecting its severity.	√	√
	– Wake turbulence weight categories.	√	√
	– Avoidance during crossing traffic, take-off and landing.	√	√
1.16	**VISIBILITY**	√	√
1.16.1	Visibility:	√	√
	– Definition and measurement.	√	√
	– Types of visibility restrictions and their definitions (mist, fog, haze, glare, smog, dust and sand).	√	√
	– Slant visibility.	√	√
1.16.2	Runway visual range (RVR):	√	√
	– Definition and measurement.	√	√

1.16.3	Fog:	√	√
	– Radiation fog.	√	√
	– Advection fog.	√	√
	– Frontal fog.	√	√
	– Orographic (upslope).	√	√
	– Steam fog.	√	√
1.17	**AIR MASSES**	√	√
	– Definition of an air mass.	√	√
	– Classification.	√	√
	– Modification.	√	√
	– Air masses affecting South Africa.	√	√
1.18	**FRONTS**	√	√
1.18.1	Mid-latitude (temperate) cyclones.	√	√
1.18.2	Cold fronts:	√	√
	– Formation, characteristics and weather.	√	√
	– Changes with the passage of the front.	√	√
	– Flying conditions and penetration procedures.	√	√
1.18.3	Warm fronts:	√	√
	– Formation, characteristics and weather.	√	√
	– Changes with the passage of the front.	√	√
	– Flying conditions and penetration procedures.	√	√
1.18.4	Occlusions:	√	√
	– Formation, characteristics and weather.	√	√
	– Flying conditions and penetration procedures.	√	√
1.18.5	Stationary fronts	√	√
1.19	**HURRICANES (TROPICAL CYCLONES)**	√	√
1.19.1	– Development and characteristics.	√	√
1.19.2	– Associated weather.	√	√
1.19.3	– Commonly occurring regions.	√	√
1.20	**CLIMATOLOGY AND WORLD WEATHER**	√	√
	– General world climatic zones.	√	√
	– ITCZ: characteristics, weather and seasonal movement.	√	√
1.20.1	Regional climatology:	√	√
	– General African climate and significant weather.	√	√
	– General Asian climate and weather. The Far East Monsoon.	√	√
	– European climate and weather. Significant weather.	√	√
	– Mediterranean climate, weather. Significant weather.	√	√
	– General North American climate and significant weather.	√	√
	– General South American climate and significant weather.	√	√
1.21	**SOUTH AFRICAN WEATHER**	√	√
1.21.1	South African climate and climatic regions.	√	√
1.21.2	South African summer patterns.	√	√
1.21.3	South African winter patterns.	√	√

1.21.4	South African weather phenomena:	√	√
	– Mid-latitude (temperate) cyclones (frontal systems).	√	√
	– Hurricanes (Tropical cyclones).	√	√
	– Coastal lows.	√	√
	– the South Westerly Buster	√	√
	– Easterly weather (the Guti).	√	√
	– The Cape Doctor	√	√
	– Cut-off lows and the Black South Easter	√	√
1.22	**METEOROLOGICAL INFORMATION**	√	√
1.22.1	SAWS aviation website – www.aviation.weathersa.co.za:	√	√
	– Basic layout.	√	√
	– Information obtainable.	√	√
1.22.2	Weather analysis and forecasting:	√	√
	– Synoptic weather charts and symbols. Station de-code.	√	√
	– Significant (prognostic) weather charts.	√	√
	– Upper winds and temperatures charts.	√	√
1.22.3	Weather information for flight planning:	√	√
	Interpretation of:	√	√
	– METAR.	√	√
	– TAF.	√	√
	– SPECI.	√	√
	– SIGMET/ AIRMET/ SPECIAL AIR REPORT.	√	√
	– Aerodrome warnings.	√	√
	– Wind shear warnings.	√	√
	– Volcanic ash advisories.	√	√
1.22.4	Meteorological broadcasts for aviation:	√	√
	– ATIS.	√	√
	– VOLMET.	√	√
1.22.5	Data collection:	√	√
1.23	– Elementary knowledge of the AMDAR system.	√	√

REF	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	√	√
	– 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	√	√
3.5	**INSTRUMENT LANDING SYSTEM (ILS)**	√	√
	– principles	√	√
	– frequencies	√	√
	– presentation and interpretation	√	√
	– range and coverage	√	√
	– errors and accuracy	√	√
	– factors affecting range and accuracy	√	√
3.6	**BASIC RADAR PRINCIPLES**	√	√
	– pulse techniques and associated terms	√	√
3.7	**GROUND RADAR**	√	√
	– principles	√	√
	– presentation and interpretation	√	√
	– coverage	√	√
	–	√	√

	range		
	– errors and accuracy	√	√
	– factors affecting range and accuracy	√	√
3.8	**AIRBORNE WEATHER RADAR**	√	√
	– principles	√	√
	– presentation and interpretation	√	√
	– coverage	√	√
	– range	√	√
	– errors and accuracy	√	√
	– factors affecting range and accuracy	√	√
	– application for navigation	√	√
3.9	**SECONDARY SURVEILLANCE RADAR (SSR)**	√	√
	– principles	√	√
	– presentation and interpretation	√	√
	– modes and codes, including mode S	√	√
3.10	**RADIO ALTIMETER**	√	√
	– principles	√	√
	– frequency band	√	√
	– presentation and interpretation	√	√
	– errors and accuracy	√	√
3.11	**GROUND PROXIMITY WARNING SYSTEM (GPWS)**	√	√
	– principles	√	√
	– warning modes	√	√
3.12	**TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS)**	√	√
	– principles of operation	√	√
	– warning modes	√	√
3.13	**DOPPLER**	√	√
	– principles of operation	√	√

	– ground speed and drift calculation	√	√
	– accuracy and reliability	√	√
	– flight deck equipment	√	√
3.14	**EMERGENCY LOCATOR TRANSMITTER (ELT)**	√	√
	– principles	√	√
	– frequencies	√	√
	– testing	√	√
3.15	**AREA NAVIGATION**	√	√
	VOR/DME area navigation (RNAV)	√	√
	– principle of operation	√	√
	– advantages and disadvantages	√	√
	– accuracy, reliability and coverage	√	√
	– use and limitations	√	√
	– flight deck equipment	√	√
3.16	**SATELLITE ASSISTED NAVIGATION: (GPS/GNSS)**	√	√
3.16.1	Global Positioning Service (GPS)	√	√
	– system capability	√	√
3.16.1.1	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	√	√
3.16.2	Differential GPS (DGPS)	√	√
	– principle of operation	√	√
	– pseudolite/GPS	√	√
3.16.3	GLONASS	√	√
	– basic concepts	√	√

REF	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	√	√
	– 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	√	√
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	Transverse Mercator	√	√
	– method of construction & oblique	√	√
	– properties	√	√
4.3.3	Lamberts Conformal Conic	√	√
	– method of construction and properties	√	√
	– representation of great circle, rhumb lines, meridians and parallels of latitude	√	√
	– plotting radio bearings	√	√
	– scale	√	√
	– 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	√	√
	–	√	√

	ircraft separation		
	– controlled time of arrival by changing speed	√	√

REF	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)	√	√
	– 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	√	√
	– 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
	– system check and updating	√	n/a
5.4	**BOEING 737 NAVIGATION EQUIPMENT AND FLIGHT MANAGEMENT**		
	Inertial Reference System (IRS)	√	n/a
	– ring laser gyro	√	n/a
	– strap-down systems	√	n/a
	– alignment	√	n/a
	– limitations and accuracy	√	n/a
	– advantages	√	n/a
	– IRS mode selector	√	n/a
	– lights	√	n/a
	– Display units	√	n/a
	– Selectors	√	n/a
	– Keyboard and enter key	√	n/a
	– Instrument transfer switch	√	n/a
	– RMI, DME, VOR, ILS, marker beacon, ADF, SSR selections	√	n/a
	– Weather radar, radio altimeters	√	n/a
	MCP		
5.5	**ELECTRONIC FLIGHT INSTRUMENT SYSTEM (EFIS) BOEING 737**	√	n/a
	– information display types	√	n/a
	– data input	√	n/a
	– control panel, display unit	√	n/a
	– typical aircraft installation	√	n/a
	EFIS symbol generator	√	n/a
	EFIS control panel	√	n/a

	EADI/EHSI	√	n/a
	Attitude display	√	n/a
	Mode annunciators	√	n/a
	Flight director commands	√	n/a
	LOC deviation displays	√	n/a
	ILS deviation warnings	√	n/a
	Rising runway displays	√	n/a
	Attitude comparator	√	n/a
	Digital radio altitude and decision height	√	n/a
	Mach, groundspeed display	√	n/a
	Pitch limit, speed tape, digital airspeed, airspeed trend, command speed, Max operating speed	√	n/a
	High speed buffet margin	√	n/a
	Next flap placard speed, flaps up manoeuvring speed,	√	n/a
	V1, VR, V2, flap retract speed, min manoeuvring speed, stick shaker speed	√	n/a
	Typical EHSI, map and plan displays	√	n/a
	Display orientation	√	n/a
	Modes and features	√	n/a
	Flags, failures and annunciators	√	n/a
	Controls	√	n/a
5.6	**FLIGHT MANAGEMENT SYSTEM (FMS)**	√	√
	– role, use and general principles	√	√
	– inputs and outputs of data	√	√
	Boeing 737 Flight management computer (FMC)	√	n/a
	Overview / General	√	n/a
	CDU function	√	n/a
	CDU page displays and status	√	n/a
	Keys, keyboards	√	n/a
	Lights, components, databases	√	n/a
	Operation	√	n/a
	LNAV/VNAV	√	n/a
	RTA Navigation	√	n/a
	Radio tuning	√	n/a
	Electrical power	√	n/a
	Terminology	√	n/a
	Executing	√	n/a
	Active/inactive	√	n/a
	Modification/ initialisation	√	n/a
	Line select, enter,	√	n/a
	Access	√	n/a
	Propagate	√	n/a
	Page sequence logic	√	n/a
	CDU messages	√	n/a
	Waypoints	√	n/a

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
	– 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	√	√
	– 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	√	√
5.11.3	Magnetic Compass	√	√
	– components and principle of operation	√	√
	– serviceability tests	√	√
	– adjustment and compensation of direct reading compass	√	√

REF	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	√
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	√
	– 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	√
	– 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	√
	– C bus bars	√
6.1.1.8.7	Transformers	√
	– unction, 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)	√
	– 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	√
	– 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)	√
	– 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	Fire/Smoke	√
	– engine fire	√
	– fire in the cabin, cockpit, freight compartment	√
	– selection of appropriate fire extinguishing agents with respect to fire classification	√
	–	√

	actions in case of over-heated brakes after aborted take-off and landing	
	– smoke in the cockpit and cabin (effects and actions taken)	√
6.1.4.4	Windshear, microburst	√
	– effects and recognition during approach/departure	√
	– actions to avoid and actions taken during encounter	√
6.1.4.5	Wake turbulence	√
	– cause	√
	– influence of speed and mass, wind	√
	– actions taken during approach, landing, take-off, crossing behind	√
6.1.4.6	Contaminated runways	√
	– types of contamination	√
	– aquaplaning: types and avoidance	√
	– braking action and braking coefficient	√
6.1.4.7	Hydroplaning	√
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	√
	– inertia	√
	– motion on a curved path	√
6.1.5.2	Airspeeds	√
	– Indicated Airspeed (IAS)	√
	–	√

	Calibrated Airspeed (CAS)	
	– 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	√
	– thickness to chord ratio	√
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	√
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	√
	– 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	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	√
	– 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	√
	– 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	√
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	√
	– 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	√
	– 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)	√
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	√
	– 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	√
	– 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	√
	– 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	√
	– 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	√
	– 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	√
	– 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	√
	– 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	√
	– 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	√
	– 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	√

REF	FLIGHT PLANNING AND PERFORMANCE – *AEROPLANE*
2.1	**AEROPLANE PERFORMANCE CLASSIFICATION**
	Class A, B, C and D aeroplanes
	Net take-off flight path
	En route limitations with one or two engines inoperative
2.2	**STAGES OF FLIGHT**
	Take-off
	Climb
	Level Flight
	Descending
	Approach and landing
2.3	**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
2.4	**METEOROLOGICAL TERMINOLOGY**
	International Standard Atmosphere (ISA)
	OAT, IOAT, TAT, SAT, RAT
	Temperature deviation from ISA
	Pressure altitude, Density altitude
	QNH, QFE, QNE
2.5	**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 (ACN/PCN)
	Balanced and Unbalanced Field Lengths
	WAT limits
2.6	**PERFORMANCE TERMINOLOGY**
	Define “steady” flight

	The forces during steady climbing and descending flight	
	The opposing forces during horizontal steady flight	
	The „thrust/power required“ and “thrust/power available” curves	
	The effect of excess thrust and power on speed and/or climb performance	
	Climb angle and climb gradient	
	Flight path angle and flight path gradient	
	Descent angle and descent gradient	
	Service and absolute ceiling	
	Range and Endurance	
	Specific fuel consumption SFC	
	Specific range SR	
2.7	**FACTORS AFFECTING AEROPLANE PERFORMANCE**	√
	Temperature	√
	Air density	√
	Aeroplane mass	√
	Aeroplane configuration	√
	Aeroplane antiskid system status	√
	Aeroplane centre of gravity	√
	Aerodrome runway surface	√
	Aerodrome runway slope	√
	The effect of flap settings	√
	The effects of different recommended power settings on range and endurance	√
	The effect of wind and altitude on maximum endurance speed	√
2.8	**USE OF AEROPLANE PERFORMANCE DATA CAP 697 & 698 – PERFORMANCE – MEDIUM RANGE JET TRANSPORT AEROPLANES**	√
2.8.1	DEFINE AND EXPLAIN THE FOLLOWING TERMS	√
	Critical engine	√
	The effect of the critical engine inoperative on the power required and the total drag	√
	The effect of engine failure on controllability under given conditions	√
	Effect of Variables on Multi-Engine Aeroplane Performance	√
	Aircraft Classification Number (ACN) and Pavement Classification Number (PCN)	√
2.8.2	TAKE-OFF AND LANDING	√
	Explain the essential forces affecting the aeroplane during take-off	√
	State the effects of thrust-to-weight ratio and flap setting on ground roll	√
	Take off Run with all engines operating and one engine inoperative.	√
	Take off Distance with all engines operating and one engine inoperative.	√
	Accelerate Stop Distance with all engines operating and one engine inoperative.	√
	Explain the effect of RWY slope as a Runway (RWY) variable on take-off distances:	√
	Explain the effect of RWY surface conditions, dry, wet and contaminated as a Runway (RWY) variable on take-off distances.	√
	Explain the effect of RWY elevation as a Runway (RWY) variable on take-off distances.	√
	Explain the effect of Aeroplane mass as a Runway (RWY) variable on take-off distances.	√

	Explain the effect of Take-off configuration as a Runway (RWY) variable on take-off distances.	√
	Explain the effect of Bleed Air configurations as a Runway (RWY) variable on take-off distances.	√
	Explain the effect of Wind as a Runway (RWY) variable on take-off distances.	√
	Explain the effect of Temperature as a Runway (RWY) variable on take-off distances.	√
	Explain the effect of Pressure altitude as a Runway (RWY) variable on take-off distances.	√
	Explain the take-off distances for specified conditions and configuration for all engines operating and one engine inoperative.	√
	Explain the effect of using clearway on the take-off distance required.	√
	Explain the influence of V1 and V2 on take-off distance.	√
	Explain the time interval allowed for between engine failure and recognition when assessing the TOD.	√
	Explain the effect of a miscalculation of V1 on the take-off distance required.	√
	Explain the accelerate-stop distance for specified conditions and configuration for all engines operating and one engine inoperative.	√
	Explain the effect of using a stop way on the accelerate- stop distance required.	√
	Explain the effect of miscalculation of V1 on the accelerate-stop distance required.	√
	Explain the effect of runway slope on the accelerate-stop distance.	√
	Explain the additional time allowance for accelerate stop distance determination and discuss the deceleration procedure.	√
	Explain the use of brakes, antiskid, use of reverse thrust, ground spoilers or lift dumpers, brake energy absorption limits, delayed temperature rise and tyre limitations.	√
	Define the terms balanced field length and unbalanced field length.	√
	Understand the relationship between take off distance, accelerate stop distance and V1 when using a balanced field and unbalanced field length.	√
	Explain the effect of a stopway on the allowed take off mass and appropriate V1 when using an unbalanced field.	√
	Explain the effect of a clear way on the allowed take off mass and appropriate V1.	√
	Define the runway length limited take-off mass for balanced and unbalanced field length.	√
	Define the segments of the actual take-off flight path.	√
	Determine changes in the configuration, power, thrust and speed in the take-off flight path segments	√
	Determine the differences in climb gradient requirements for 2, 3 and 4 engine aeroplanes.	√
	Describe the influence of airspeed selection, acceleration and turns on the climb gradients, best rate of climb speed and best angle of climb speed.	√
	Determine the climb limited take-off mass.	√
	Obstacle-limited take-off	√
	Describe the operational regulations for obstacle clearance in the net take-off flight path.	√
	Define actual and net take-off flight path with one engine inoperative.	√
	Determine the obstacle limited take-off mass.	√
	Define Performance limited take-off mass.	√
	Take off Performance using different take off flap settings	√

	Explain the advantages and disadvantages of using different take off flap settings to optimise the Performance limited take off mass	√
	Take off Performance using increased V2 speeds ("improved climb performance")	√
	Explain the advantages and disadvantages of using increased V2 speeds	√
	Explain under what circumstances this procedure can be used.	√
	Brake energy and tyre speed limit	√
	Explain the effects on take-off performance of brake energy and tyre speed limits.	√
	Explain under which conditions this becomes limiting.	√
	CLIMB	√
	Climb techniques	√
	Explain the effect of climbing with constant IAS.	√
	Explain the effect of climbing with constant Mach number.	√
	Explain the correct sequence of climb-speeds for jet transport aeroplanes	√
	Determine the effect on TAS when climbing in and above the troposphere at constant Mach number	√
	Explain the effect of aeroplane mass on the Rate of Climb (ROC).	√
	Explain the effect of meteorological variables on the Rate of Climb (ROC).	√
	Explain the effect of aeroplane acceleration during a climb with constant IAS or Mach number	√
	Explain the effect on the operational speed limit when climbing at constant IAS.	√
	Explain the term "cross over altitude" which occurs during the climb speed schedule (IAS-Mach number).	√
	Calculate the time, fuel and distance to climb.	√
2.8.3	CRUISE	√
	Define cruise procedures "max endurance" and "max range"	√
	Explain fuel flow in relation to TAS and thrust	√
	Find speed for max endurance.	√
	Define the term maximum range.	√
	Define the term long range cruise	√
	Explain differences in flying the speed for long range and maximum range with regard to fuel flow and speed stability	√
	Explain the effect and centre of gravity (CG) position and actual mass of aircraft on range and endurance	√
	Explain the effect of altitude on range and endurance	√
	Explain the effect of meteorological variables on range and endurance	√
	Define the term optimum altitude	√
	Explain the factors which affect the choice of optimum altitude	√
	Explain the factors which might affect or limit the maximum operating altitude	√
	Explain the necessity for step climbs	√
	Determine the all engines operating power settings and speeds from the aeroplane performance data sheets for Maximum range.	√
	Determine the all engines operating power settings and speeds from the aeroplane performance data sheets for High speed and normal cruise.	√
	Determine the all engines operating power settings and speeds from the aeroplane performance data sheets for High and low speed buffet (speed/Mach number only).	√

	Determine the selection of cruise technique accounting for cost indexing, passenger requirements against company requirements.	√
	Determine the fuel consumption from the aeroplane performance data sheets for various cruise configurations, holding, approach and transit to an alternate in normal conditions and after an engine failure	√
2.8.4	EN-ROUTE ONE ENGINE INOPERATIVE	√
	Drift Down.	√
	Determine the minimum obstacle clearance height.	√
	Define the speed during drift down	√
	Explain influence of deceleration on the drift-down profiles	√
	Influence of variables on En-route One Engine Inoperative performance.	√
	Find one-engine out service ceiling, range and endurance given engine inoperative charts.	√
	Find maximum continuous power/thrust settings given engine inoperative charts	√
2.8.5	DESCENT	√
	Descent techniques	√
	Explain the effect of descending with constant Mach number.	√
	Explain the effect of descending with constant IAS.	√
	Explain the correct sequence of descent speeds for jet transport aeroplanes	√
	Determine the effect on TAS when descending in and above the troposphere at constant Mach number	√
	Describe Maximum operating speed and Maximum Mach number VMO.	√
	Explain the effect of a descent at constant Mach number on the margin to low and high speed buffet.	√
	Influence of variables on descent performance.	√
	Explain the influence of mass, configuration and altitude on rate of descent and glide angle.	√
	Determine the information for all engines operating and one engine inoperative from the aeroplane performance data sheets for Descent rates.	√
	Determine the information for all engines operating and one engine inoperative from the aeroplane performance data sheets for Time and distance for descent.	√
	Determine the information for all engines operating and one engine inoperative from the aeroplane performance data sheets for Fuel used during descent.	√
2.8.6	APPROACH AND LANDING	√
	Explain the effect of temperature and pressure altitude on approach and landing climb performance	√
	Define the landing distance available (LDA)	√
	Explain the effect of runway slope, surface conditions and wind on the maximum landing mass for a given runway length.	√
	Explain the effect on landing distance and maximum allowable landing mass with reverse affecting deceleration.	√
	Explain the effect on landing distance and maximum allowable landing mass with anti-skid affecting deceleration.	√
	Explain the effect on landing distance and maximum allowable landing mass with ground spoilers or lift dumpers affecting deceleration.	√
	Explain the effect on landing distance and maximum allowable landing mass with auto brakes affecting deceleration	√
	Explain the effect of temperature and pressure altitude on the maximum landing mass for a given runway length.	√

	Explain the effect of hydroplaning on landing distance required	√
	Quick turnaround limit	√
	Define the quick turnaround limits and explain their purpose.	√
	Determine the Field length required for landing with a given landing mass from the aeroplane performance data sheets.	√
	Determine the landing and approach climb limited landing mass from the aeroplane performance data sheets.	√
	Determine the landing field length limited landing mass from the aeroplane performance data sheets.	√
	Find the structural limited landing mass from the aeroplane performance data sheets.	√
	Calculate the maximum allowable landing mass as the lowest of: – Approach climb and landing climb limited landing mass, – Landing field length limited landing mass, – Structural limited landing mass.	√
	Determine the maximum quick turnaround mass and time under given conditions from the aeroplane performance data sheets.	√
	Determine the Limiting landing mass in respect of PCN.	√
2.9	**MASS AND BALANCE**	
2.9.1	TERMINOLOGY	√
	Define and explain the meaning of centre of gravity	
	CG limits – forward and aft	√
	Define datum (reference point), arm and moment	
	Conditions of equilibrium (Balance of Forces and Balance of Moments)	
	Mean aerodynamic chord (MAC), (LEMAC)	√
	Maximum Zero Fuel Mass	
	Maximum Ramp/Taxi Mass	
	Maximum Take-off Mass	
	Empty Operating Mass	√
	Maximum Landing Mass	√
	Use of cargo pallets	
	Maximum floor load	
	Cargo compartment limitations	
	Define the following load terms: Payload, Taxi Fuel, Take off Fuel, Trip Fuel/ Burn off, Reserve Fuel (Contingency, Alternate, Final Reserve and Additional Fuel) and Extra Fuel.	
	Calculating payload without exceeding mass limitations	√
2.9.2	MASS LIMITATIONS	
	The relationship between aircraft mass and structural stress	
	The relationship between aircraft mass and performance	
	Centre of gravity (CG) limitations	
	The relationship between CG position and stability/controllability of aircraft	
	The effects if CG is in front of the forward limit and if CG is behind the aft limit	
	Describe the relationship between CG position and aircraft performance	
	Calculate maximum allowed payload and fuel load not to exceed given Allowed Mass for Take-off, Zero Fuel and Landing.	

2.9.3	CALCULATION OF CG	√
	The principle of calculating the aircraft's CG position	
	Calculating CG for Medium Range Jet Transport Aeroplane CAP 696	
	The principle of using % MAC for the description of the CG position	
	Calculate the CG position as % MAC	
	Loading of aircraft not exceeding CG limitation	√
	Maximum load at station not exceeding CG limitation	
	Movement of CG in flight	
	Influence of weight shift on CG	√
	Influence of weight loss on CG	
	Ballast	√
2.10	**FLIGHT PLANNING GENERAL**	
	PET AND PNR	√
	PET (point of equal time)	√
	CP (critical point)	√
	PNR (point of no return)	√
	PSR (point of safe return)	√
	SPECIFIC PERFORMANCE	
	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	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	√
2.2.4	**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	√
	– Cockpit and cabin weight and moment tables	√
	– Usable fuel weight and moment table	√
	– Engine oil weight and moment table	√
2.2.5.4	Forward climb performance, best rate of climb speed tables	√
2.2.5.5	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	√
	– 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)	√
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	