Ground Examination Syllabus

Commercial Pilot's Licence (Aeroplanes)

Commercial Pilot's Licence (Helicopters and Gyroplanes)

CPL (A) - NAVIGATION GROUP OF SUBJECTS

NAVIGATION SUBJECTS

1 RADIO AIDS

1.1 **Electro magnetic radiation**
1.1.1 Speed of propagation
1.1.2 Frequency/wavelength
1.1.3 Phase/phase difference
1.1.4 Frequency bands

1.2 **Basic radio transmitter**
1.2.1 Signal generation
1.2.2 Feeding and emission of RF signals

1.3 **Antennas**
1.3.1 Characteristics
1.3 2 Polarisation
1.3.3 Use of antennas

1.4 **Modulation of radio waves**
1.4.1 Amplitude, frequency and pulse modulation
1.4.2 Classification of emission

1.5 **Wave propagation**
1.5.1 Factors affecting range and propagation of ground, direct and sky waves
1.5.2 Height of ionospheric layers
1.5.3 Ducted propagation, tropospheric scatter

1.6 **Radio communications**
1.6.1 Long and short range systems
1.6.2 Frequencies/frequency bands used
1.6.3 S S B
1.6.4 Selcal
1.6.5 Satcom

1.7 **Ground D/F**
1.7.1 Principles
1 7.2 Coverage and range
1.7.3 Errors and accuracy (including classification of bearing accuracy)
1.7.4 Factors affecting range and accuracy
1.8 **ADF/NDB**

1.8.1 Principles
1.8.2 Coverage and range (including protection)
1.8.3 Errors and accuracy
1.8.4 Factors affecting range and accuracy
1.8.5 Presentation and interpretation (including use of the RMI)

1.9 **VOR (*Conventional and Doppler)***
1.9.1 Principles
1.9.2 Coverage and range (including DOC)
1.9.3 Errors and accuracy
1.9.4 Factors affecting range and accuracy
1.9.5 Presentation and interpretation (including use of the RMI)

1.10 **ILS**
1.10.1 Principles
1.10.2 Coverage and range
1.10.3 Errors and accuracy
1.10.4 Factors affecting range and accuracy (including categories)
1.10.5 Presentation and interpretation

1.11 **MLS**
1.11.1 Principles
1.11.2 Coverage and range
1.11.3 Errors and accuracy
1.11.4 Factors affecting range and accuracy
1.11.5 Presentation and interpretation

1.12 **Basic Radar Principles**
1.12.1 Advantages/disadvantages of primary/secondary radars
1.12.2 Pulse techniques and associated terms

1.13 **DME**
1.13.1 Principles
1.13.2 Coverage and range
1.13 3 Errors and accuracy
1.13.4 Factors affecting range and accuracy
1.13.5 Presentation and interpretation

1.14 **VOR/DME area navigation (RNAV)**
1 14.1 Principle of operation
1.14 2 Advantages and disadvantages
1.14.3 Accuracy, reliability and coverage
1.14.4 Presentation and interpretation
1.14.5 Use of DME to update INS/FMS

1.15 **SSR**
1.15.1 Application for navigation
1.15.2 Principles, (including Mode 'S' data link)
1.15.3 Presentation and interpretation

1.16 **Ground radar**
1.16.1 Principles
1.16.2 Coverage and range
1.16 3 Presentation and interpretation
1.16 4 Errors and accuracy
1.16.5 Factors affecting range and accuracy

1.17 **Airborne weather radar**
1.17.1 Principles
1.17.2 Coverage and range
1.17.3 Errors and accuracy
1.17.4 Factors affecting range and accuracy
1.17.5 Presentation and interpretation

1.18 **Ground Proximity Warning System (GPWS)**
1.18.1 Function
1.18.2 Data inputs
1.18.3 Warning modes
1.18.4 Mode limits
1.18.5 Integrity testing

1.19 ***Very low frequency systems*** *(Omega* ***and*** *VLF)*
1.19.1 *Principle of operation*
1.19.2 *Derivation of a position line*
1.19.3 *Ground station locations*
1.19.4 *Advantages and disadvantages*
1.19.5 *Errors and factors affecting accuracy*
1.19.6 *Reliability, range and coverage*
1.19.7 *Presentation of information/flight deck equipment*

1.20 **Traffic Collision Avoidance System (TCAS)**
1.20.l Principles
1.20.2 Warnings

1.21 **Hyperbolic Navigation Systems**
1.21.1 Basic Principles
1.21.2 Range and accuracy
1.21.3 Factors affecting range and accuracy

1.22 **Decca Navigation System**
1.22.1 Principle of operation
1.22.2 Derivation of position line
1.22.3 Advantages and disadvantages
1.22.4 Master and slave station
1.22.5 Accuracy, reliability, range and coverage
1.22.6 Modern automatic systems
1.22.7 Flight deck equipment, presentation of information
1.23 **Loran-C**

1.23.1 Principle of operation
1.23.2 Derivation of a position line
1.23.3 Advantages and disadvantages
1.23.4 Accuracy, reliability, range and coverage
1.23.5 Presentation of information
1.23.6 Automatic systems

1.24 **Satellite Assisted Navigation**
1.24.1 Basic Principles
1.24.2 Derivation of a position line
1.24.3 Accuracy, reliability, range and coverage
1.24.4 Automatic systems

1.25 **Doppler**
1.25.1 Principle of operation

1.26 **Radio Altimeter**
1.26.1 Principles
1.26.2 Errors and accuracy
1.26.3 Presentation and interpretation

2 FLIGHT PLANNING AND FLIGHT MONITORING

2.1 **Flight Plans for Cross Country Flights**
2.1.1 Navigation plan
2.1.2 Terrain and obstacle clearance
2.1.3 Cruising levels
2.1.4 Navigation check points, visual *or* radio
2.1.5 Measurement of tracks and distances
2.1.6 Obtaining wind velocity forecast for each leg
2.1.7 Computation of headings, ground speeds and times from tracks, true airspeeds and wind velocities
2.1.8 Use of wind component, tables for drifts and ground speeds
2.1.9 Completion of navigation flight plan

2.2 **Fuel plan**
2.2.1 Computation of planned fuel usage for each leg and total *fuel* for the flight
2.2.2 Flight manual figures for fuel flow during climb, cruise and descent. Mid weights or instantaneous weights
2.2.3 Navigation plan for times en-route
2.2.4 Fuel for holding or diversion
2.2.5 Reserves
2.2.6 Total fuel requirements for flight
2.2.7 Take off weight
2.2.8 Landing weight
2.2.9 Completion of pre-flight portion of fuel log

2.3 **Flight Monitoring and In-Flight Re-planning**

2.3.1	In-flight computations
2.3.2	Recording of fuel quantities, recalculation at navigational checkpoints, flight progress charts
2.3.3	Calculation of actual rate of consumption
2.3.4	Comparison of actual and planned fuel consumption and fuel state, flight progress chart, PNR and CP
2.3.5	Revision of fuel reserves
2.3.6	In-flight re-planning
2.3.6.1	Selection of cruise altitude for new destination
2.3.6.2	Fuel state, fuel requirements, fuel reserves

2.4	**Radio Communications and Navigation Aids**
2.4.1	Communication frequencies and call signs for appropriate control agencies and in-flight service facilities, weather stations
2.4.2	Radio navigation and approach aids
2.4.3	Type
2.4.3.1	Frequencies
2.4.3.2	Identification

2.5	**Air traffic flight plan**
2.5.1	CA48 flight plan
2.5.2	ICAO flight plan
2.5.3	Format
2.5.4	Information included
2.5.5	Repetitive flight plan
2.5.6	Completion of flight plan
2.5.7	Information for flight plan obtained from:
2.5.7.1	Navigation flight plan
2.5.7.2	Fuel endurance
2.5.7.3	Operator's records for basic information

2.6	**Practical Flight Planning**
2.6.1	Chart usage
2.6.2	Checking AIPs and Notams for latest information
2.6.3	Selection of altitudes or flight levels for each leg of flight
2.6.4	Plotting tracks and measuring directions and distances
2.6.5	Completing navigation plans using:
2.6.5.1	Tracks and distances from prepared charts
2.6.5.2	Wind velocity on each leg to obtain headings and ground speeds
2.6.5.3	Times for each leg to destination and alternates to determine total time en-route
2.6.6	Simple fuel plans
2.6.7	Preparation of fuel loads showing planned values for:
2.6.7.1	Fuel used on each leg including climb, cruise and descent
2.6.7.2	Fuel remaining at end of each leg
2.6.7.3	Total time and fuel required to destination
2.6.7.4	Completion of fuel plan
2.6.7.5	Fuel required for missed approach, climb and cruise to alternate
2.6.7.6	Reserve fuel

2.7	**Radio Planning**
2.7.1	Communications
2.7.1.1	Frequencies and call signs of ATC agencies and facilities and information for in-flight weather
2.7.2	Navigation aids
2.7.2.1	Frequencies and identifiers of en-route and terminal facilities
2.8	**IFR (Airways) Flight Planning**
2.8.1	Meteorological considerations
2.8.2	Selection of routes to destination and alternates
2.8.2.1	Preferred airways routes
2.8.2.2	Extraction of tracks/distances from radio nav charts
2.8.2.3	Frequencies and identifiers of en-route radio nav aids
2.8.2.4	Minimum en-route altitudes, minimum crossing and reception altitudes
2.8.2.5	Standard instrument departures (SIDS) and standard arrival routes (STARs)
2.8.2.6	Interpretation and use of aerodrome charts: landing charts, instrument approach charts, visual approach charts, noise abatement charts, special procedure charts
2.9	***Use of radio navigation charts (inside and outside controlled airspace)***
2.9.1	*Frequencies) call signs/designators of ATC agencies*
2.9.2	*Determination of ATC frequencies to be used*
2.9.3	*Frequencies/identifiers of navigation aids*
2.9.4	*Preferred routes*
2.9.5	*Choice of route*
2.9.6	*Minimum en-route/minimum crossing/minimum reception altitudes*
2.9.7	*MORA/safe clearance altitude*
2.9.8	*Selection of flight levels*
2.9.9	*Determination of tracks and distances*
2.9.10	*Selection of alternates*
2.9.11	*Interpretation and use of other information on radio navigation charts*
2.9.12	*SlDs and STARs*
3	**NAVIGATION**
3.1	**The Earth**
3.1.1	Form of the earth: rotation, great circle, small circle, rhumb line, geographic poles
3.1.2	Position on earth: latitude and longitude, use of co-ordinates to find position, difference of latitude and longitude
3.1.3	Direction on earth: true north, magnetic north, compass north, variation, deviation, isogonals
3.1.4	Convergency and conversion angle: definitions, formula, application
3.1.5	Distance on earth: units of measurement, nautical miles, kilometres, statute miles, conversion, relationship to latitude
3.1.6	Speed: units of measurements (knots, mph, kph), RAS, TAS, reach number relationship, ground speed
3.1.7	Time: distance, speed and time solutions

3.2	**The Triangle of Velocities**
3.2.1	Vectors: heading, track, drift, TAS, ground speed
3.2.2	Computer solution
3.2.3	Multi-drift wind velocities, wind components, maximum and minimum components for take-off and landing
3.3	**Fuel**
3.3.1	Use of computer for fuel conversions: kilograms, litres, pounds, imperial gallons, US gallons
3.3.2	Solution of fuel flow problems, fuel units in relation to time
3.4	**Pilot navigation**
3.4.1	The 1 in 60 rule: track error, closing angles, distance gone, regaining and paralleling track, altering heading to destination, DR navigation
3.5	**Charts**
3.5.1	Types of projection, general properties, orthomorphism, scale, chart convergency
3.5.2	Properties of the:
3.5.2.1	Mercator
3.5.2.2	Lambert Conformal
3.5.2.3	Use of the charts, calculation of bearings at various positions
3.5.3	Topographical maps, conventional signs
3.6	**Emergency Data**
3.6.1	Calculation and application of critical point and point of no return
3.6.2	Calculation and application of radius of action or latest time to divert
3.7	**Relative Velocity**
3.7.1	Principles of relative velocity
3.7.2	Assessment of collision risk (not interception)
3.8	**Time and Time Conversions**
3.8.1	Solar system, seasonal and apparent movements of the sun
3.8.2	Basis of mean time, civil day, the years
3.8.3	LMT, ST, UTC using air almanac extracts
3.8.4	Sunrise, sunset, twilight using air almanacs extracts
3.9	**Navigation Plotting**
3.9.1	Calculation of factors affecting accuracy and plotting of DR position
3.9.2	Measurement of track and distance, assessment of magnetic variation
3.9.3	Plotting of position lines from radio facilities, establishment of aircraft position by transference of straight and curved position lines by track and groundspeed, use of single position lines, fixing by position lines
3.9.4	Calculation of actual track and groundspeed by reference to plotted position, calculation of actual wind velocity. Revision of ETA and fuel endurance
3.9.5	Navigation on climb and descent
3.9.6	Maintaining a flight log

4 INSTRUMENTS

4.1 Air Data Sources

4.1.1 Pitot and static systems
4.1.1.1 Pitot tube
4.1.1.1.1 Construction and principle of operation
4.1.1.1.2 Errors and faults
4 1.1.2 Static source
4.1.1.2.1 Construction, principle of operation and siting
4.1.1.2.2 Errors and faults
4.1.1.3 Combined pressure head
4.1.1.3.1 Construction, principle of operation and siting
4.1.1.3.2 Errors and faults
4.1.1.4 Alternate static source
4.1.1.4.1 Siting
4.1.1.4.2 Errors normally associated with alternate vent
4.1.2 Air temperature measurement
4.1.2.1 Types of thermometer used
4.1.2.2 Ram air temperature
4.1.2.3 Corrected outside air temperature
4.1.2.4 Errors

4.2 Air data instruments

4.2.1 Altimeter
4.2.1.1 Relationship of pressure and height
4.2.1.2 Principle of operation and construction of sensitive and servo altimeters
4.2.1.3 Height encoding
4.2.1.4 Sub-scale setting, standard settings, QFE, QFE(threshold), QNH
4.2.1.5 Interpretation of instrument
4.2.1.6 Errors
4.2.1.7 Corrections and tolerances
4.2.1.8 Altimeter correction, determination of corrections due to surface pressure variation

4.2.3 Airspeed indicator (ASI)

4.2.3.1 Effect of motion of body through atmosphere
4.2.3.2 Ram air pressure
4.2.3.3 Dynamic pressure
4.2.3.4 Compressibility
4.2.3.5 Speed terms: IAS, EAS, RAS/CAS, TAS
4.2.3.6 Construction and principle of operation
4.2.3.7 Interpretation of instrument
4.2.3.8 Use of coloured arcs and other markers
4.2.3.9 Errors and corrections
4.2.3.10 Conversion of IAS to TAS
4.2.4 Vertical speed indicator (VSI)
4.2.4.1 Rate of ascent and descent as a rate of change of pressure
4.2.4.2 Simple VSI

4.2.4.2.1 Principle
4.2.4.2.2 Presentation
4.2.4.2.3 Use
4.2.4.2.4 Errors and limitations
4.2.4.3 Inertial lead VSI (IVSI)
4.2.4.3.1 Principle
4.2.4.3.2 Presentation
4.2.4.3.3 Advantages
4.2.4.3.4 Errors and limitations
4.2.5 Mach meter
4.2.5.1 Significance of mach number
4.2.5.2 Mach number formula
4.2.5.3 Measurement of mach number as ratio of pressures
4.2.5.4 Construction and principle of operation
4.2.5.5 Presentation, interpretation and use
4.2.5.6 Errors
4.2.6 Mach/Airspeed Indicator (MASI)
4.2.6.1 Principle of operation
4.2.6.2 Presentation, interpretation and use
4.2.6.3 Errors

4.3 **Gyroscopic instruments**
4.3.1 Gyroscopic principles
4.3.1.1 Theory of gyroscopic principles
4.3.1.2 Rigidity in space, apparent drift, apparent tilt
4.3.1.3 Precession, real drift, real topple
4.3.1.4 Factors affecting precession rates
4.3.1.5 Construction and principle of operation of:
4.3.1.5.1 Vertical gyro
4.3.1.5.2 Directional gyro
4.3.1.5.3 Rate gyro
4.3.1.5.4 Rate integrating gyro
4.3.1.5.5 Single degree of freedom gyro
4.3.1.5.6 Solid state gyro
4.3.2 Direction indicator (DI)
4.3.2.1 Construction and principle of operation
4.3.2.2 Errors
4.3.2.3 Need to set and re-set
4.3.3 Remote indicating compass (RIC)
4.3.3.1 Construction and principle of operation
4.3.3.2 Principle of the flux valve
4.3.3.3 Remote transmission system
4.3.3.4 Slaving system
4.3.3.5 Advantages
4.3.3.6 Output data, use and applications
4.3.3.7 Pre-flight check
4.3.4 Artificial horizon
4.3.4.1 Construction and principle of operation
4.3.4.2 Remote vertical gyro

4.3.4.3 Types of display
4.3.4.4 Errors and limitations
4.3.4.5 Output data, use and applications
4.3.5 Turn and balance indicator
4.3.5.1 Construction and principle of operation
4.3.5.2 Display types and interpretation
4.3.5.3 Errors and limitations
4.3.5.4 Output data, use and applications
4.3.6 Turn co-ordinator
4.3.6.1 Construction and principle of operation
4.3.6.2 Display and interpretation
4.3.6.3 Errors and limitations

4.4 **Magnetism and Compasses**
4.4.1 Principles of magnetism
4.4.1.1 Terrestrial magnetism
4.4.1.1 Earth's total magnetic field
4.4.1.2 H and Z components and their values as governed by magnetic latitude
4.4.1.3 Directive force, magnetic dip, variation
4.4.2 Aircraft magnetism
4.4.2.1 Permeability of materials, hard iron and soft iron
4.4.2.2 Magnetic field of an aircraft, effect on directive force
4.4.2.3 Deviation, change with heading, change with magnetic latitude
4.4.2.4 Compass safe distances
4.4.2.5 MCAR limits
4.4.3 Direct reading magnetic compasses (DRMC)
4.4.3.1 Principle of construction
4.4.3.2 Errors and limitations
4 4.3.3 Serviceability tests
4.4.3.4 The deviation card

4.5 **Electronic Displays and Systems**
4.5.1 Area navigation systems
4.5.1.1 Typical flight deck equipment
4.5.1.2 Input sources, use, crew interface
4.5.1.3 Interpretation, checking and updating
4.5.2 Electronic flight instrument systems (EFIS)
4 5.2.1 Types of display
4.5.2.2 Block diagram of data inputs
4.5.2.3 Interpretation and use of information
4.5.3 Flight management system (FMS)
4.5.3.1 General function and principle
4.5.3.2 Inputs and outputs
4.5.3.3 Use and application

4.5.4 Flight director systems
4.5 4.1 Function and application
4 5 4.2 Block diagram, components and display
4.5.4.3 Mode of operation

4.5.4.4 Limitations, operational restrictions
4.5.5 Inertial Navigation Systems (INS)
4 5.5 1 Function and application
4.5.5.2 Modes of operation
4.5.5.3 limitations

5 METEOROLOGY (THEORY)

5.1 Composition and properties of the Atmosphere

5.2 Pressure, temperature and density of the Atmosphere

5.2.1 Barometric pressure, isobars, isallobars
5.2.2 Diurnal variation of pressure, pressure variation with height
5.2.3 Determination of QFF
5.2.4 Transfer of heat, solar and terrestrial radiation, conduction, turbulence, convection, radiation
5.2.5 Temperature near earth's surface, surface effects, diurnal variation, effect of clouds, effect of wind and humidity
5 2.6 Elementary heat balance in atmosphere
5.2 7 Adiabatic processes, dry air, evaporation, condensation, latent heat, saturated air, simple temperature/height diagram
5.2.8 Vertical distribution of temperature, troposphere, tropopause, stratosphere, lapse rate, types of inversion, influence on weather
5.2.9 Stability and instability: changes caused by radiation, turbulence, convection, advection, subsidence, convergence, divergence
5.2.10 Density, variation at the surface and with height. Aircraft performance and density

5.3 Humidity

5.3.1 Water vapour in the atmosphere
5.3.2 Dry/wet bulb temperature, dewpoint, and relative humidity
5.3.3 Condensation, precipitation, sublimation and freezing in the atmosphere
5.3.4 Relationship between density, pressure, temperature and humidity. The International Standard Atmosphere (ISA)

5.4 Clouds and precipitation

5.4.1 Composition of cloud, methods of formation, height of base and vertical extent. international nomenclature and classification of cloud types
5.4.2 Turbulence, orographic, stratiform and convection cloud structure and classification.
5.4.3 Thunderstorms, development and structure, development and effects of microburst, associated flight hazards, atmospheric electricity (lightning and static)
5.4.4 Types of precipitation: drizzle, rain, snow, hail
5.4.5 General causes of precipitation, precipitation associated with different types of cloud
5.4.6 Operating hazards associated with various types of cloud and precipitation

5.5	**Wind**
5.5.1	Relationship between isobars and wind, Buys Ballot's law
5.5.2	Primary cause of wind, pressure gradient, geostrophic force and geostrophic wind, coriolis force, gradient wind, convergence and divergence effects (no formulae)
5.5.3	Diurnal variation of wind at the surface and on top of the friction layer. Winds and isobars near the equator
5.5.4	Local variation of wind with topography: ravine wind, anabatic and katabatic effects, Fohn effect, land and sea breezes
5.5.5	Airflow over mountains: standing waves and conditions favourable for their development, rotor streaming
5 5.6	Turbulence, gustiness and squalls, factors affecting turbulence
5.5.7	Low level wind shear: effect on aircraft operation, weather situations favourable for formation, recognition, action to be taken
5.5.8	Variation of wind with height.
5.6	**Visibility**
5.6.1	Fog, mist, haze and their differences
5 6.2	Formation and clearance of radiation fog, advection fog, steam fog and frontal fog. Diurnal and seasonal variations
5.6.3	Reduction of visibility caused by mist, smoke, dust, sand, snow and sea spray
5.6.4	Vertical and oblique visibility, visual illusions in flight caused by precipitation
5.6.5	Runway visual range (RVR) and Instrumented runway visual range (IRVR)
5.7	**Ice accretion**
5.7.1	Forms of airframe icing, relation to cloud types, factors affecting form and severity, hazards
5.7.2	Action to take on encountering icing conditions
5.7.3	Power plant icing
5.8	**Air masses and fronts**
5.8.1	Description, classification and characteristics of air masses including warm fronts, cold fronts and occlusions
5.8.2	Depressions, anticyclones, cols and their associated weather
5.9	**The Weather Map**
5.9.1	Interpretation of symbols and figures used on weather charts
5.9.2	The development and movement of simple pressure systems and fronts
5.9.3	Interpretation of synoptic chart and use of the synoptic chart for the preparation of a route forecast and landing forecasts
5.9.4	Effects of topographic features and diurnal variation on development of weather
5.10	**Observations**
5.10.1	Knowledge of standard methods of measuring visibility and cloud height also pressure, temperature, humidity and wind at the surface and in the upper air. (A knowledge of the mechanics of the various instruments is not required)

5.10.2 The Q code groups QFE, QNE, QNH, QFF and Regional QNH

5.11 **Flight Documentation**

5.11.1 Interpretation of flight forecast documents. (Changes in documentation take place from time to time. Examination questions will reflect current practice)

5.11.2 Decoding of TAF, METAR and SIGMET messages. TREND type landing forecasts and the criteria for their use

6 METEOROLOGY (PRACTICAL)

A test in the practical application of knowledge covered by paragraph 5