Ground Examination Syllabus

ATPL (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 Transmitter**
1.2.1 Signal generation
1.2.2 Feeding and emission of R F 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
1.4.3 Basic principles of Doppler effect

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 propagations, tropospheric scatter

1.6 **Radio Communications**
1.6.1 Long and short range communications 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
1.12.3 Cathode ray tube
1.12.4 Production of a basic time-base

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
1.15.4 Method of producing modes and special codes

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 **Doppler**
1.18.1 Principle of operation

1.19 **Radio Altimeter**
1.19.1 Principles
1.19.2 Errors and accuracy
1.19.3 Presentation and interpretation

1.20 **Ground Proximity Warning System (GPWS)**
1.20.1 Function
1.20.2 Data inputs
1.20.3 Warning modes
1.20.4 Mode limits
1.20.5 Integrity testing

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

1.24 ***Very Low Frequency Systems (Omega and*** *VLF)*
1.24.1 Principle of operation
1.24.2 Derivation of a position line
1.24.3 Ground station locations
1.24.4 Advantages and disadvantages
1.24.5 Errors and factors affecting accuracy
1.24.6 Reliability, range and coverage
1.24.7 Presentation of information and flight deck equipment

1.25 **Satellite Assisted Navigation.**
1.25.1 Basic principles
1.25.2 Derivation of a position line
1.25.3 Accuracy, reliability, range and coverage
1.25.4 Automatic systems

1.26 **Traffic Collision Avoidance System**
1.26.1 Principles
1.26.2 Warnings

2 FLIGHT PLANNING AND FLIGHT MONITORING

2.1 **Flight Plans for Cross Country Flights**
2.1.1 Navigation Plan
2.1.1.1 Terrain and obstacle clearance
2.1.1.2 Cruising levels
2.1.1.3 Navigation check points, visual or radio
2.1.1.4 Measurement of tracks and distances
2.1.1 5 Obtaining wind velocity forecast for each leg
2.1 1.6 Computation of heading, ground speeds and times from tracks, true airspeeds and wind velocities
2.1.1.7 Use of wind component tables for drift and groundspeeds
2.1.1.8 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
2.3.1.1 Recording of fuel quantities, recalculation at navigational checkpoints, Flight Progress Chart
2.3.1.2 Calculation of actual rate of consumption
2.3.1.3 Comparison of actual and planned fuel consumption and fuel state, Flight Progress Chart; PNR and CP
2.3.2 Revision of fuel reserves
2.3.3 In-flight re-planning
2.3.3.1 Selection of cruise altitude for new destination
2.3.3.2 Fuel state, fuel requirements, fuel reserves

2.4 **Radio Communications and Navigational 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
2.4.2.1 Type
2.4.2.2 Frequencies
2.4.2.3 Identification

2.5 **Air Traffic Flight Plan**
2.5.1 Type of flight plan
2.5.2 ICAO flight plan
2.5.2.1 Format
2.5.2.2 Information included
2.5.2.3 Repetitive flight plan
2.5 3 Completion of flight plan
2.5.4 Information for flight plan obtained from:
2.5.4.1 Navigation flight plan
2.5.4.2 Fuel endurance
2.5.4.3 Operators records for basic information

2.6 **Practical Flight Planning**
2.6.1 Chart usage
2.6.1.1 Checking AIP and Notams for latest information
2.6.1.2 Selection of altitudes or flight levels for each leg of flight
2.6.2 Plotting tracks and measuring directions and distances
2.6.3 Completing navigation plans using:
2.6.3.1 Tracks and distances from prepared charts
2.6.3.2 Application of wind velocity on each leg to obtain headings and ground speeds
2.6.3.3 Times for each leg to destination and alternates to determine total time en-route
2.6.4 Simple fuel plans
2.6.5 Preparation of fuel loads showing planned values for:
2.6.5 1 Fuel used on each leg including climb, cruise and descent
2.6.5.2 Fuel remaining at end of each leg

2.6.5 3 Total time and fuel required to destination
2.6.5.4 Endurance, based on fuel remaining and planned rate of consumption at end of each leg
2.6.5.5 Completion of fuel plan
2.6.5.6 Fuel required for missed approach, climb and cruise to alternate
2.6.5.7 Reserve fuel

2.7 **Radio Planning Practice**
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 navigation charts
2.8.2.3 Frequencies and identifiers of en-route radio navigation aids
2.8.2.4 Min 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 **Jet Aircraft Flight Planning (Additional considerations)**
2.9.1 Additional aspects
2.9.1.1 Cruise technique
2.9.2 Fuel planning
2.9.2.1 En-route contingency fuel
2.9.2.2 Destination holding and diversion fuel
2.9.2.3 Reserves
2.9.2.4 Importance of altitude selection when planning for diversion
2.9.2.5 Use of performance charts
2.9.3 Calculation of critical point (CP), Point of no return (PNR)
2.9 4 Difference between equi-fuel and equi-time points
2.9.4.1 General Consideration of EROPS, Point of Equal Time (PET) and Point of Safe Return (PSR)

2.10 **Computerised Flight Planning**
2.10.1 General principles of present systems
2.10.1.1 Advantages
2.10.1 2 Shortcomings and limitations

3 NAVIGATION

3.1 **The Earth**
3.1.1 Form of the earth: rotation, great circles, small circles, rhumb lines,

	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, Grid North Variation, deviation, grivation, isogonals, isogrivs
3.1.4	Convergency and conversion angle: definitions, formula, application
3.1.5	Departure: definition, formula, application
3.1.6	Distance on Earth: units of measurement, (nautical miles, kilometres, statute miles), conversion, relationship to latitude
3.1.7	Speed: units of measurement (knots, mph; kilometres per hour), Rectified Airspeed, True Airspeed, Mach Number relationship; Groundspeed
3.1.8	Time: distance, speed and time solutions
3.2	**The Triangle of Velocities**
3.2.1	Vectors: Heading, Track, Drift; TAS, Groundspeed, Wind Velocity
3.2.2	Computer solution (also to be covered during plotting)
3.2.3	Solution of multi-drift wind velocities, head and crosswind components; Maximum and minimum wind 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 (to include representation of great circles, rhumb lines, parallels of latitude and meridians; scale problems; chart convergency) of the projections:
3.5.2.1	Mercator
3.5.2.2	Transverse Mercator
3.5.2.3	Oblique Mercator
3.5.2.4	Lambert Conformal
3.5.2.5	Polar Stereographic
3.5.3	Use of the projections listed above
3.5.4	Topographical Maps; conventional signs
3.6	**Navigation Requirement for Long Range Flights**
3.6.1	Route selection, choice of speed and flight level; minimum time tracks
3.6.2	Polar Flights
3.6.2.1	Gridded charts: grivation, convergency, variation relationship, use in North and South Polar Areas
3.7	**Emergency Data**
3.7.1	Calculation and application of Critical Point and Point of No Return

3.7.2 Calculation and application of Radius of Action or latest time to divert

3.8 **Relative Velocity**
3.8.1 Principles of Relative Velocity
3.8.2 Assessment of Collision Risk (not interception)

3.9 **Time and Time Conversions**
3.9.1 Solar System, seasonal and apparent movements of the sun
3.9.2 Basis of Mean time, Civil Day, The Years
3.9.3 LMT, ST, UTC using air almanac extracts
3.9.4 Sunrise, sunset and twilight using air almanac extracts

3.10 **Navigation Plotting**
3.10.1 Calculation factors affecting accuracy and plotting of Dead Reckoning position
3.10.2 Measurement of track and distance, assessment of Magnetic variation
3.10.3 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
3.10.4 Calculation of actual track and groundspeed by reference to plotted position, calculation of actual wind velocity. Revision of ETA and fuel endurance
3.10.5 Use of external aids for INS cross checks
3.10.6 Navigation on climb and descent
3.10.7 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 use of 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
4.1.3 Angle of Attack Sensor(Blade angle sensors/dial - helicopters)
4.1.3.1 Principle of operation

4.1.3.2	Types in use
4.1.3.3	Outputs
4.1.3.4	Use and application
4.1.3 5	Displays

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	Subscale setting procedures, 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
4.2.2	Airspeed Indicators (ASI)
4.2.2.1	Effect of motion of body through atmosphere
4.2.2.2	Ram air pressure
4.2.2.3	Dynamic pressure
4.2.2.4	Compressibility
4.2.2.5	Speed terms: IAS, EAS, RAS/CAS, TAS
4.2.2.6	Construction and principle of operation
4.2.2.7	Interpretation of instrument
4.2.2.8	Use of coloured arcs and other markers
4.2.2.9	Errors and corrections
4.2.2.10	Conversion of IAS to TAS
4.2.3	Vertical Speed Indicator (VSI)
4.2.3.1	Rate of ascent and descent as a rate of change of pressure
4.2.3.2	Simple VSI
4.2.3 2.1	Principle
4.2.3.2 2	Presentation
4.2.3.2.3	Use
4.2.3.2.4	Errors and limitations
4.2.3.3	Inertial lead VSI
4.2.3.3.1	Principle
4.2.3.3.2	Presentation
4.2.3.3.3	Advantages
4.2.3.3.4	Errors and limitations
4.2.4	Mach Meter
4.2.4.1	Significance of Mach number
4.2.4.2	Mach number formula
4.2.4.3	Measurement of Mach No. as a ratio of pressures
4.2.4.4	Construction and principles of operation of a machmeter
4.2.4.5	Presentation, interpretation and use
4.2.4.6	Errors
4.2.5	Mach/TAS Indicator
4.2.5.1	Principle of operation
4.2.5.2	Presentation, interpretation and use

4.2.5.3 Errors
4.2.6 Air Data Computers (ADC)
4.2.6.1 Principles of operation
4.2.6.2 Sources of input data
4.2.6.3 Output data, uses and systems fed
4.2.6.4 Block diagram
4.2.6.5 System monitoring

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 Directional indicator (DI)
4.3.2.1 Construction and principles of operation
4.3.2.2 Errors
4.3.2.3 Need to set and re-set
4.3.3 Remote indicating compasses (RIC)
4.3.3.1 Construction and principles of operation
4.3.3.2. Principles of the flux valve
4.3.3.3 The slaving system
4.3.3.4 Advantages
4.3.3.5 Output data, use and application
4.3.3.6 Pre-flight check
4.3.3.7 Remote transmission systems
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 principles of operation
4.3.6.2 Display and interpretation
4.3.6.3 Errors, cautions and limitations
4.3.7 Accelerometers

4.3.7.1	Principles
4.3.7.2	Construction of typical force re-balanced accelerometer
4.3.7.3	Errors and limitations of measurement
4.3.7.4	Output data, uses
4.3.8	Gyro Stabilised Gimballed Platform
4.3.8.1	Construction and principle of operation
4.3.8.2	Platform levelling and gyro compassing
4.3.8.3	Platform alignment
4.3.8.4	Types of platform
4.3.8.5	Output data, uses and applications
4.3.9	'Strapped Down' Systems
4.3.9.1	Construction and principles of operation
4.3 9.2	Types in use
4.3.9.3	Advantages/disadvantages
4.3.10	Inertial Navigation
4.3.10.1	Use of accelerometers and platforms
4.3.10.2	Schuler - tuned platforms
4.3.10.3	Principles of integration
4.3.10.4	Navigation computer
4.3.10.5	Use of equipment
4.3.10.6	MSU and CDU, HSI display
4.3.10.7	Accuracy, reliability and errors
4.3.10.8	INS operational use

4.4	**Magnetism and Compasses**
4.4.1	Principles of magnetism
4.4.1.1	Terrestrial magnetism
4.4.1.2	Earth's total magnetic field
4.4.1.3	'H' and 'Z' components and their values as governed by magnetic latitude
4.4.1 4	Directive force, Magnetic dip, Variation
4.4.1.5	Aircraft magnetism
4.4.1.6	Permeability of materials, hard iron and soft iron
4.4.1.7	Magnetic field of an aircraft, effect on directive force
4.4.1.8	Deviation: change with heading, change with magnetic latitude
4.4.1.9	Compass safe distances
4.4 1.10	MCAR /JAR limits
4.4.2	Direct Reading Magnetic Compass (DRMC)
4.4.2.1	Principles of construction
4.4.2.2	Errors and limitations
4.4.2.3	Examples of a magnetic compass
4.4.2.4	Serviceability tests
4.4.2.5	An appreciation of the methods and devices used to compensate a direct reading magnetic compass (DRMC). Determination of coefficients A, B and C
4.4.2.6	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 up-dating
4.5.2	Electronic flight instrument systems (EFIS)
4.5.2.1	Types of information
4.5.2.2	Block diagrammatic data input
4.5.2.3	Control panel, data unit
4.5 2 4	Typical installation
4.5.2.5	Interpretation and use of information
4.5.3	Flight Management System (FMS)
4.5.3.1	General function and principles
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	Operational setup for various flight phases
4.5.4.5	Command modes (bars)
4.5.4.6	Mode indicator
4 5.4.7	System monitoring
4.5.4.8	Limitations, operational restrictions.

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, atmospheric equilibrium, development of inversions, types of inversions, influence on the weather
5.2.9	Stability and instability: changes caused by radiation, turbulence, convection, advection, subsidence, convergence, divergence and precipitation
5.2.10	Density, variation at surface and with height. Aircraft performance and air density
5.3	**Humidity**
5.3.1	Water vapour in the atmosphere
5.3.2	Vapour pressure, effect of humidity on density
5.3.3	Dry/wet bulb temperature, dewpoint, humidity mixing ratio, absolute, and

	relative humidity
5.3.4	Condensation, precipitation, sublimation and freezing in the atmosphere
5.3.5	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. Conditions favourable for formation. Structure and classification. Diurnal and seasonal variation
5.4 3	Thunderstorms, development and structure, development and effect 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	Characteristics of orographic, frontal and shower precipitation
5.4.7	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, effect of turbulence on lapse rates
5.5.7	Low level wind shear: effect on aircraft operation, weather situations favourable for low level windshear, methods of recognition, action to be taken on encountering
5.5.8	Variation of wind with height: elementary knowledge of thermal component of the wind, contour charts, jet streams in all parts of the world and their seasonal variation
5.6	**Flights at higher levels (upper troposphere and stratosphere)**
5.6.1	Upper clear air turbulence (CAT): cause, location, effect on aircraft, description for met reports
5.6.2	Stratospheric conditions: tropopause influence on aircraft performance, jetstreams, CAT and clouds, effects of ozone, radioactivity
5.7	**Visibility**
5.7.1	Fog, mist, haze and their difference
5.7.2	Formation and clearance of radiation fog, advection fog, steam fog and frontal

	fog, diurnal and seasonal variation
5.7.3	Reduction of visibility caused by mist, smoke, dust, sand, snow and sea spray
5.7.4	Vertical and oblique visibility, visual illusions in flight caused by precipitation
5.7.5	RVR (Runway visual Range) and IRVR (Instrumented Runway Visual Range)
5.8	**Ice Accretion**
5.8.1	Forms of airframe icing, relation to cloud types, factors affecting form and severity, hazards
5.8 2	Action to take on encountering icing conditions
5.8.3	Power plant icing
5.9	**Airmasses**
5.9.1	Description, factors affecting properties
5.9.2	Classification, modifications due to advection, areas of origin
5.10	**Fronts**
5.10.1	Boundaries between airmasses, general situation
5.10.2	Warm front associated clouds and weather
5.10.3	Cold front, associated clouds and weather
5.10.4	Weather in the warm sector, hazards for aviation
5.10.5	Occlusion, associated clouds and weather
5.10.6	Quasi-stationary front, associated clouds and weather
5.11	**Airmasses and Frontal Analysis**
5.11.1	Frontal depressions: formation of warm and cold fronts, occlusion process, distribution of weather, depression families, troughs, flight conditions in and over depressions
5.11.2	Non-frontal depressions: thermal, orographic (lee) and secondary depressions, tropical revolving storms, tornadoes, water-spouts
5.11.3	Anticyclones, types, general properties cold and warm anticyclones, ridges and cols
5.11.4	Prognostic rules, movement of fronts and developments of fronts, movement of pressure systems and development of pressure systems
5.12	**Climatology**
5.12.1	The average surface pressure and temperature distribution over the world
5.12.2	Average circulation patterns in the troposphere and lower stratosphere and their seasonal variation
5.12.3	Upper winds, stream lines and seasonal variation
5.12.4	The Inter Tropical Convergence Zone (ITCZ) and associated weather in different areas
5.12.5	Winds and weather of the monsoon regions
5.12.6	Tropical storms, origin and local names, periods of occurrence, easterly waves and hurricane development
5.12.7	Flying conditions in the vicinity of tropical storms
5.12.8	Meteorological phenomena of special interest to aviators with reference to the synoptic situations giving rise to such phenomena (e.g. tropical cyclones, tornadoes, dust and sandstorms, freezing precipitation)
5.12.9	Aviation climatology of the principal air routes and areas of the world

5.12.10 Local winds by name such as Mistral, Bora, Scirocco, Harmattan

5.13 **The Weather Map**

5.13.1 Interpretation of symbols and figures used on weather charts

5.13.2 The development and movement of simple pressure systems and fronts, including significance of isallobaric changes

5.13.3 Interpretation of synoptic charts and use of the synoptic chart for the preparation of a route forecast and landing forecasts. Effects of topographic features and diurnal variation on development of weather

5.14 **Observations**

5.14.1 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)

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

5.14.3 In-flight observations: reporting criteria; form and circumstances in which observations are made and reported

5.14.4 The use of satellite photographs

5.15 **Flight Documentation**

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

5.15.2 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