COMPLETE SYLLABUS OF AIR NAVIGATION IS AS FOLLOWS:

1 – Air Navigation

a) Basics of Navigation –

The solar system – seasonal and apparent movements of the sun – The earth – great circle, small circle, rhumb line – convergency, conversion angle – latitude, difference of latitude – longitude, difference of longitude – use of latitude and longitude co-ordinates to locate any specific position – Time and time conversions – apparent time – UTC – LMT – standard times – international dateline – Directions – terrestrial magnetism: declination, deviation and compass variations – magnetic poles, isogonals, relationship between true and magnetic – Distance – units of distance and height used in navigation: nautical miles, statute miles, kilometers, metres, yards and feet – conversion from one unit to another – relationship between nautical miles and minutes of latitude.

b) Magnetism and Compasses –

General principles – terrestrial magnetism – resolution of the earth's total magnetic force into vertical and horizontal components – the effects of change of latitude on these components – directive force – magnetic dip – variation – Aircraft magnetism – hard iron and vertical soft iron – the resulting magnetic fields – the variation in directive force – Change of deviation with change of latitude and with change in aircraft's heading – turning and acceleration errors – keeping magnetic materials clear of the compass – knowledge of the principles, standby and landing or main compasses and remote reading compasses – detailed knowledge of the use of these compasses – serviceability tests – advantages and disadvantages of the remote indicating compasses – adjustment and compensation of direct reading magnetic compass.

c) Charts –

General properties of miscellaneous type of projections – Mercator – Lambert conformal conic – Polar stereographic – Transverse mercator – Oblique mercator – The representation of meridians, parallels, great circles and rhumb lines – direct Mercator – Lambert conformal conic – Polar Stereographic – The use of current aeronautical charts – plotting positions – methods of indicating scale and relief – conventional signs – measuring tracks and distances – plotting bearings.

d) Dead Reckoning Navigation (DR) –

Basics of dead reckoning – track – heading (compass, magnetic, true, grid) – wind velocity – airspeed (IAS, CAS, TAS, Mach number) – ground speed – ETA – drift, wind correction angle – DR-position, fix – Use of the navigational computer – speed – time – distance – fuel consumption – conversions – heading – airspeed – wind velocity – The triangle of velocities, methods of solution for the determination of – heading – ground speed – wind velocity – track and drift angle, track error – time and distance problems – Determination of DR position – need for DR – confirmation of flight progress (mental DR) – lost procedures – heading and TAS vector since last confirmed position – application of wind velocity vector – last known track and ground speed vector – assessment of accuracy of DR position – Measurement of DR elements – calculation of altitude, adjustments, corrections, errors – determination of temperature – determination of appropriate speed – determination of mach number – Resolution of current DR problems by means of – mercator charts – lambert charts – polar stereographic projections – Measurement of – maximum range – radius of action – point-of-safe-return and point-of-equal-time – Miscellaneous DR uncertainties and practical means of correction.

e) In-flight Navigation –

Use of visual observations and application to in-flight navigation – Navigation in climb descent – average airspeed – average wind velocity – ground speed/distance covered during climb or descent – Navigation in cruising flight, use of fixes to revise navigation data as – ground speed revision – off-track corrections – calculation of wind speed and direction – ETA revisions – Flight log (including navigation records).

2 – Mass and Balance – Aeroplanes

a) Introduction to Mass and Balance –

Centre of gravity (cg): Definition, importance in regard to aircraft stability (Aeroplane) – Mass and balance – consult aeroplane flight manual for: cg limits for take-off, landing, cruise configurations – maximum floor load – maximum ramp and taxi mass (Aeroplane) – factors determining maximum permissible mass : structural limitations, performance limitations such as – runway available for take-off and landing, weather conditions (temperature, pressure, wind, precipitation); rate-of-climb and altitude requirements for obstacle clearance; engine-out performance requirements – factors determining cg limits: aircraft stability, ability of flight controls and surfaces to overcome mass and lift pitching moments under all flight conditions, changes in cg location during flight due to consumption of fuel, raising and lowering of undercarriage, and intentional relocation of passengers or cargo, transfer of fuel, movement of centre of lift because of changes in position of wing flaps.

b) Loading –

Terminology: empty mass, dry operating mass (empty mass + crew + operating items + unusable fuel), zero fuel mass, standard mass – crew, passengers and baggage, fuel, oil water (volume/mass conversion factors), carry-on luggage, useful load (traffic load + usable fuel – Effects of overloading: high take-off and safety speeds, longer take-off and landing distances, lower rate-of-climb, influence on range and endurance, decreased engine-out performance, possible structural damage in extreme cases.

c) Centre of Gravity (cg) –
basic of cg calculations (load and balance documentation) – Datum – explanation of term, location, use in cg calculation – Moment arm – explanation of term, determination of algebric signs, use – Moment – explanation, moment = mass x moment arm – Expression in percentage of mean aerodynamic chord (% MAC) – Calculation of cg – Effect of load-shift – movement of cg. Possible out of limits – possible damage due to inertia of a moving load – effect of acceleration of the aircraft load.

3 – Performance

a) Performance of Single-Engine Aeroplanes –
definitions of terms and speeds used – Take-off and landing performance – Effect of aeroplane mass, wind, density, altitude, runway slope, runway conditions – Use of aeroplane flight manual data – Climb and cruise performance – use of aeroplane flight data – effect of density altitude and aeroplane mass – endurance and the effects of the different recommended power settings – still air range with various power settings.

b) Performance of Multi-Engine Aeroplanes –

definitions of terms and speeds used – any new terms used for multi-engine aeroplane performance – Importance of performance calculations – determination of performance under normal conditions – consideration of effects of pressure altitude, temperature, wind, aeroplane mass, runway slope, and runway conditions – Elements of performance – take-off and landing distances – obstacle clearance at take-off – rate of climb and descent – effects of selected power settings, speeds, and aircraft configuration – Cruise altitudes and altitude ceiling – en-route requirements – Payload/range trade-offs – Speed/economy trade-offs – Use of performance graphs and tabulated data – performance section of flight manual.

4 – Flight Planning and Monitoring – Aeroplanes

a) Flight Plans for Cross Country Flights –
Navigation Plan – selection of routes, speeds, heights (altitudes) and alternate airfield/landing sites – terrain and obstacle clearance – cruising levels appropriate for direction of flight – navigation check points, visual or radio – measurement of tracks and distances – obtaining wind velocity forecast for each leg – computations of headings, ground speeds, and time en-route from tracks, true airspeed and wind velocities – completion of pre-flight portion of navigation flight log – Fuel Plan – computation of planned fuel usage for each leg and total fuel usage for the flight – flight manual figures for fuel flow during climb, enroute and during descent – navigation plan for times en-route – fuel for holding and diversion to alternate airfield – reserves – total fuel requirements for flight – completion of pre-flight portion of fuel log – Flight monitoring and in-flight re-planning – in-flight fuel computations – recording of fuel quantities remaining at navigational checkpoints – calculation of actual consumption rate – comparison of actual and planned fuel consumption and fuel state – Revision of fuel

reserve estimates – in-flight re-planning in case of problems – selection of cruise altitude and power settings for new destination – time to new destination – fuel state, fuel requirements, fuel reserves – Radio communication and navigation aids – communication frequencies and call signs for appropriate control agencies and in-flight service facilities such as weather stations – radio navigation and approach aids, if appropriate – type – frequencies – identification.

b) ICAO ATC Flight Plan –
types of flight plan – ICAO flight plan – format – completing the flight plan – Filling the flight plan – procedures for filing – agency responsible for processing the flight plan – Adherence to flight plan.

c) Practical Flight Planning –
Chart preparation – Plot tracks and measure directions and distances – Navigation plans – Completing the navigation plan using: – tracks and distances from prepared charts – wind velocities as provided – true airspeeds as appropriate – Simple fuel plans – Preparation of fuel logs showing planned values for: – fuel used on each leg – fuel remaining at the end of each leg – endurance, based on fuel remaining and planned consumption rate, at end of each leg – Radio planning practice – Communications – frequencies and call signs of air traffic control agencies and facilities and for in-flight services such as weather information.

d) Practical Completion of a 'Flight Plan' (flight plan, flight log, nav log ATC plan, etc.) –
Extraction of data – extraction of navigational data – extraction of meteorological data – extraction of performance data – completion of navigation flight plan – completion of fuel

plan – time and fuel to top-of-climb – cruise sector times and fuel used – total time and fuel required to destination – fuel required for missed approach, climb enroute altitude, and cruise alternate – reserve fuel – Completion of air traffic flight plan

5 – Radio Navigation

a) Radio Aids –
Ground D/F (including classification of bearings) – principles – presentation and interpretation – coverage – range – errors and accuracy – factors affecting range and accuracy – ADF (including associated beacons and use of the radio magnetic indicator) – principles – presentation and interpretation – coverage – range – errors and accuracy – factors affecting range and accuracy – VOR and Doppler – VOR (including the use of the radio magnetic indicator) – principles – presentation and interpretation – coverage – range – errors and accuracy – factors affecting range and accuracy – DME (distance measuring equipment) – principles – presentation and interpretation – coverage – range – errors and accuracy – factors affecting range and accuracy – ILS (Instrument Landing System) – principles – presentation and interpretation – coverage – range – errors and accuracy – factors affecting range and accuracy.

b) Basic Radar Principles –
SSR secondary surveillance radar and transponder – principles – presentation and interpretation – modes and codes, including mode S.

c) Self-contained and External-Referenced Navigation Systems –

Satellite assisted navigation: GPS / GLONASS – principle of operation – advantages and disadvantages

6 – Instrumentation

6.1 Flight Instruments

a) Air data instruments –

pitot and static system – pitot tube, construction and principles of operation – static source – malfunction – heating – alternate static source – Altimeter – construction and principles of operation – display and setting – errors – correction tables – tolerances – Airspeed indicator – construction and principles of operation – speed indications (IAS) – meaning of coloured sectors – maximum speed indicator, VMO, MMO pointer – errors – Vertical Speed Indicator (VSI) – aneroid and instantaneous VSI (IVSI) – construction and principles of operation – display.

b) Gyroscopic instruments –

Gyro fundamentals – theory of gyroscopic forces (stability, precession) – types, and principles of operation: – vertical gyro – directional gyro – rate gyro – rate integrating gyro – single degree-of-freedom gyro – ring laser gyro – apparent drift – random drift – mountings – drive types, monitoring – Directional gyro – construction and principles of operation – Slaved gyro compass – construction and principles of operation – components – mounting and modes of operation – turn and acceleration errors – application, uses of output data – Attitude indicator (vertical gyro) – construction and principles of operation – display types – turn and acceleration errors – application, uses

of output data – Turn and bank indicator (rate gyro) – construction and principles of operation – display types – application, uses of output data – turn coordinator.

c) Magnetic Compass –
construction and principles of operation – errors (deviation, effect of inclination).

d) Radio Altimeter –
components – frequency band – principle of operation – displays – errors.

6.2 Power Plant and System Monitoring Instruments –
Pressure Gauge – sensors – pressure indicators – meaning of coloured sectors – Temperature Gauge – ram rise, recovery factor – RPM Indicator – interfacing of signal pick-up to RPM gauge – RPM indicators, piston and turbine engines – meaning of coloured sectors – Consumption Gauge – high pressure line fuel flowmeter (function, indications, failure warnings) – Fuel Gauge- measurement of volume/mass, units – measuring sensors – content, quantity indicators – reasons for incorrect indications – Torque Meter – indicators, units – meaning of coloured sectors – Basics of Electronic Displays – EFIS – EICAS – ECAM – FMS – Basic radio propagation theory – Basic principles – Electromagnetic waves – Wave length, amplitude, phase angle, frequency – Frequency bands, side band, single side band – Pulse characteristics – Carrier, modulation, demodulation – Kind of modulation (amplitude, frequency, pulse, multiplex) – Oscillation circuit – Antennas – Characteristics – Polarization – Types of antennas – Wave propagation – Ground wave – Space wave – Propagation with the frequency bands – Frequency prognosis (MUF) – fading – Factors affecting propagation (reflection, absorption, interference, twilight, shoreline, mountain, static).