APPENDIX 'C'

RADIO AIDS AND INSTRUMENTATION
(AVIONICS)

THE SYLLABUS OF RADIO AIDS AND INSTRUMENTATION IS AS FOLLOWS:

1. 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**

- Pulse techniques and associated terms – latitude and longitude

- Ground Radar
  - principles
  - presentation and interpretation
  - coverage
  - range
  - errors and accuracy
  - factors affecting range and accuracy

- Airborne weather radar
  - principles
  - presentation and interpretation
  - coverage
  - range
  - errors and accuracy
  - factors affecting range and accuracy
  - application for navigation

- SSR secondary surveillance radar and transponder
  - principles
  - presentation and interpretation
  - modes and codes, including mode S

- Use of radar observations and application to in-flight navigation

c) Area Navigation System

- General philosophy
  - use of radio navigation systems or an inertial navigation system

- Typical flight deck equipment and operation
  - means of entering and selecting waypoints and desired course information (keyboard entry system)

- means of selecting, tuning and identifying ground stations
- instrumentation for en-route course guidance
- for some types of systems, instrumentation for presenting distance traveled, distance to go and, if necessary, ground speed information
- instrumentation for presenting current position data
- flight detector and autopilot coupling

- Instrument indications

- Types of area navigation system inputs
  - self-contained on-board systems (IRS/IRS systems)
  - external sensor systems (VOR/DME, GPS)
  - air data inputs (true airspeed, altitude, magnetic heading)

- VOR/DME area navigation (RNAV)
  - principle of operation
  - advantages and disadvantages
  - accuracy, reliability, coverage
  - flight deck equipment

- Flight director and autopilot coupling

d) Self-contained and external-referred navigation systems

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

e) Inertial Navigation/Reference System (INS/IRS)

- Principles and practical application
  - gyroscopic principles
  - platform mounting
  - accelerometer principles
  - integrator principles
  - shuller-tuned platform
  - navigation computer
  - strap down system

- Alignment procedures
  - gyrocompassing
  - leveling
- Accuracy, reliability, errors and coverage

- Flight Check equipment and operation
  - mode selector unit (MSU)
  - control display unit (CDU)
  - horizontal situation indicator (HIS)
  - INS operation

- Normal flight, position and waypoint entries
- Flight Plan changes
- Bypassing waypoint
- Change of waypoint data
  - system check and updating

2 Instrumentation

2.1 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, V_{MO}, M_{MO} pointer
  - pointer

- Mach meter
  - mach number formula
  - construction and principles of operation
  - display
  - errors

- Vertical Speed Indicator (VSI)
  - aneroid and instantaneous VSI (IVSI)
  - construction and principles of operation
  - display

- Air Data Computer (ADC)
  - principles of operation
  - input and output data, signals
  - uses of output data
  - block diagram
  - system monitoring

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
  - principles of operation

- Slaved gyro compass
  - principles of operation
  - components
  - mounting and modes of operation
  - turn and acceleration errors
  - application, uses of output data

- Attitude indicator (vertical gyro)
  - principles of operation
  - display types
  - turn and acceleration errors
  - application, uses of output data

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

- Gyro stabilized platform (Gimballed platform)
  - types in use
  - accelerometer, measurement systems
  - construction of principles of operation
  - platform alignment
  - application, uses of output data

- Fixed installations (strap down systems)
  - construction and principles of operation
  - types in use
  - input signals
  - application, uses of output data

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

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

2.2 Automatic Flight Control Systems

a) Flight Director

- function and application
- block diagram, components
- mode of operation

- operation set-up for various flight phases
- command modes (bars)
- mode indicator
- system monitoring
- limitations, operational restrictions

b) Autopilot

- autoland, sequence of operation
- system concepts for autoland, go-around, take-off, fail passive, fail operational (redundant)

c) Basic concepts of the following

- Flight envelope protection
- Yaw Damper / Stability Augmentation System
- Automatic Pitch Trim
- Auto-thrust

2.3 Warning and Recording Equipment

a) Warnings general
- classification of warning
- display, indicator systems

b) Altitude Alert System
- function
- block diagram, components
- operation and system monitoring

c) Ground Proximity Warning System (GPWS)
- function
- block diagram, components
- input data, signals
- system integrity test

d) Traffic Collision Avoidance System (TCAS)
- function
- warning modes

e) Over-speed Warning
- function
- input data, signals
- display, indicators

- function test
- effects on operation in case of failure

f) Stall Warning
- function
- constituent components of a simplified system
  - block diagram, components of a system with angle of attack indicator
- operation

g) Flight Data Recorder (FDR)
- function
- block diagram, components
- operation
- system monitoring

h) Cockpit Voice Recorder (CVR)
- function
- block diagram, components
- operation

2.4 Power Plant and System Monitoring Instruments

a) Pressure Gauge
- sensors
- pressure indicators
- meaning of coloured sectors

b) Temperature Gauge
- ram rise, recovery factor

c) RPM Indicator
- interfacing of signal pick-up to RPM gauge
- RPM indicators, piston and turbine engines
- meaning of coloured sectors

d) Consumption Gauge
- high pressure line fuel flow-meter (function, indications, failure warnings)

e) Fuel Gauge
- measurement of volume / mass, units
- measuring sensors
- content, quantity indicators
- reasons for incorrect indications

f) Torque Meter
- indicators, units
- meaning of coloured sectors

g) Flight Hour Meter
- drive source
- indicators

h) Vibration Monitoring
- indicators, units
- interfacing to bypass turbofan engine
- warning system

i) Electronic Displays
- EFIS
- EICAS
- ECAM
- FMS

j) Basic radio propagation theory

- Basic principles
  - electromagnetic waves
  - wave length, amplitude, phase angle, frequency
  - frequency bands, sideband, single sideband
  - pulse characteristics
  - carrier, modulation, demodulation
  - kinds of modulation (amplitude, frequency, pulse, multiplex)
  - oscillation circuits

- Antennas
  - characteristics
  - polarization
  - types of antennas

- Wave propagation
  - ground wave
  - space waves
  - propagation with the frequency bands
  - frequency prognosis (MUF)
  - fading
  - factors affecting propagation (reflection, absorption, interference, twilight, shoreline, mountain, static)