

## **Subject No. 44      Instruments and Navigation Aids (Aeroplane)**

**NOTE:** *This syllabus is based on a multi engine turbine air transport type aeroplane.*

*The instruments and navigation aid items within this subject are those typically found in an airline-operated air-transport type aeroplane.*

*Assessment of this syllabus will include, but not be limited to, specific approved 'representative' aircraft*

Each subject has been given a subject number and each topic within that subject a topic number. These reference numbers will be used on knowledge deficiency reports and will provide valuable feedback to the examination candidate.

This syllabus presupposes a knowledge and understanding already attained at instrument rating level.

### **Air Data Instruments**

#### **44.2      Machmeter**

- 44.2.2      Explain the principle of operation of a Machmeter.
- 44.2.4      State the effect of temperature on the Mach number.
- 44.2.6      Describe the change in Mach number with a change in altitude at a constant IAS or TAS.
- 44.2.8      Describe the change of TAS and IAS with a change in altitude at a constant Mach number.
- 44.2.10     Use the Mach number formula to calculate Mach number, TAS or temperature, given two of the three variables.
- 44.2.12     Explain the following errors affecting a Machmeter:
  - (a) instrument
  - (b) position (pressure) error and
  - (c) lag.
- 44.2.14     Explain the symptoms, effects, and possible remedies available for blockages and leaks on the Machmeter.
- 44.2.16     State the serviceability checks for a Machmeter.

#### **44.4      Air data computer (ADC)**

- 44.4.2      State the purpose of the air data computer.
- 44.4.4      Explain the operating principle of the air data computer.
- 44.4.6      Describe the ADC inputs, outputs and the supplied units.
- 44.4.8      With the aid of a diagram, describe the processing of the input data of an ADC.
- 44.4.10     Explain the backup functions of the air data computer in the case of a pressure source blockage.
- 44.4.12     Describe the effect of loss of input/output signal of the ADC to the pilot's instrument indication.

**44.6 Air temperature gauge**

44.6.2 Explain the principle of operation of an air temperature gauge.

44.6.4 Define and compare the following temperatures:

(a) Total Air Temperature (TAT)

(b) Static Air Temperature (SAT)

(c) Outside Air Temperature (OAT).

44.6.6 Name and compare the measuring probes for total air temperature.

44.6.8 Calculate OAT given TAT and Mach number.

44.6.10 Calculate the true OAT, given indicated OAT, probe recovery factor and Mach number.

44.6.12 Calculate SAT given TAT and Mach number.

**Integrated Flight Instrument Systems**

**44.8 Flight director (FD)**

44.8.2 Explain the purpose of the flight director computer.

44.8.4 Explain the operating principle of the flight director computer.

44.8.6 Interpret the information provided by the split cue and integrated cue flight director command bars.

44.8.8 List the performance and navigation parameter guidance provided by the flight director.

44.8.10 Explain the function of the flight mode annunciator.

44.8.12 Describe the task of the gain program in the approach mode.

**44.10 Electronic flight instrument system (EFIS)**

44.10.2 Explain the operating principle of the EFIS.

44.10.4 Describe the inputs available to a typical EFIS.

44.10.6 Describe the outputs from a typical EFIS.

44.10.8 State the function and describe the operation of the EFIS control panel.

44.10.10 Given appropriate drawings of a typical aircraft installation, explain the EFIS function and information interchange.

44.10.12 Describe the switching options in case of EFIS display failure.

44.10.14 Describe the function of the Electronic Attitude Director Indicator/Primary Flight Display (EADI/PFD).

44.10.16 Identify the information available on the EADI/PFD.

44.10.18 Describe the colour coding on the EADI/PFD.

- 44.10.20 Describe the function of the Electronic Horizontal Situation Indicator/Navigation Display (EHSI/ND).
- 44.10.22 Name the typical display modes for EHSI/ND.
- 44.10.24 Given suitable diagrams of instrument presentation, use an EHSI/ND to determine an aircraft's track, position and/or orientation.
- 44.10.26 Identify the information available in the different modes of the EHSI/ND.
- 44.10.28 Describe the colour coding on the EHSI/ND.
- 44.10.30 Explain the operating principle of a Head-Up-Display (HUD).
- 44.10.32 Describe the inputs available to a Head-Up-Display (HUD).
- 44.10.34 Identify the information on a Head-Up-Display (HUD).
- 44.10.36 Explain the operating principle of a synthetic vision display.
- 44.10.38 Describe the inputs available to a synthetic vision display.
- 44.10.40 Identify the information on a synthetic vision display.

#### **44.12 Electronic engine displays (ECAM, EICAS)**

- 44.12.2 Explain the purpose of the Electronic Centralized Aircraft Monitoring (ECAM) system and Engine Indication and Crew Alerting System (EICAS).
- 44.12.4 Describe the information available from an ECAM/EICAS system.
- 44.12.6 Describe the inhibiting functions in relation to different flight phases.
- 44.12.8 Describe the display units (DU) of ECAM/EICAS System.
- 44.12.10 Interpret the important colours used by the DUs.
- 44.12.12 State the redundancy provisions, in the case of a DU failure.

#### **Warning Systems**

#### **44.14 Master warning system**

- 44.14.2 Explain the function of a master warning system.
- 44.14.4 Explain the operating principle of a master warning system.
- 44.14.6 Explain the meaning of the following four degrees of urgency:
- (a) warnings
  - (b) cautions
  - (c) advisories and
  - (d) status messages.
- 44.14.8 Explain and give examples of:
- (a) visual alerts
  - (b) aural alerts and

(c) tactile alerts.

44.14.10 Explain the reasons for inhibiting alerts.

**44.16 Altitude alerter system**

44.16.2 Explain the function of an altitude alerter system.

44.16.4 Describe how to operate the altitude alerter system and how to interpret the information.

44.16.6 Describe the comparative relationship between the selected altitude and the actual altitude.

44.16.8 Explain how the system is monitored.

**44.18 Radar altimeter**

44.18.2 State the function of a radio altimeter.

44.18.4 Explain the principle of operation of the radio altimeter.

44.18.6 State the frequency band in which the radio altimeter operates.

44.18.8 State the purpose of the decision height warning light.

44.18.10 Describe the operator control options for a radio altimeter.

44.18.12 State the maximum range for indication.

44.18.14 List instruments or units which receive altitude information from the radio altimeter.

44.18.16 Describe the errors of the radio altimeter.

**44.20 Terrain awareness warning system (TAWS)**

44.20.2 Describe the function of the terrain awareness warning system.

44.20.4 Explain the principle of operation of TAWS.

44.20.6 Identify the standard TAWS warning profiles.

44.20.8 List and describe the different warning modes.

44.20.10 Explain the relationship between TAWS and EFIS navigation displays.

**44.22 Aircraft collision avoidance system (ACAS)**

44.22.2 Describe the function of the ACAS.

44.22.4 Explain the principle of operation of ACAS.

44.22.6 Identify the equipment with which an intruder must be fitted in order to be detected by ACAS.

44.22.8 Describe the appropriate ACAS graphic symbols.

44.22.10 Define a Resolution Advisory (RA) and a Traffic Advisory (TA).

44.22.12 State the minimum equipment requirements for the issuing of a Resolution Advisory and a Traffic Advisory.

44.22.14 Describe the proximity requirements for the issuing of a Resolution Advisory and a Traffic Advisory.

44.22.16 Describe ACAS “escape manoeuvres”.

44.22.18 State how many “escape manoeuvres” ACAS equipment can calculate simultaneously.

#### **44.24 Take-off configuration warning system**

44.24.2 Explain the purpose of a take-off configuration warning system.

44.24.4 Explain the operating principle of a take-off configuration warning system.

44.24.6 Give examples of configuration errors typically warned of.

#### **44.26 Overspeed warning**

44.26.2 Explain the function of the overspeed warning system.

44.26.4 Explain the principle of operation of an overspeed warning system.

44.26.6 Describe the warnings generated by the overspeed warning system and explain how these warnings can be cancelled.

#### **44.28 Stall warning system**

44.28.2 Describe the function of the stall warning system.

44.28.4 Explain the principle of operation of the stall warning system.

44.28.6 Indicate the regulatory margin between stall and stall warning.

44.28.8 Identify the inputs of a stall warning system.

44.28.10 Describe the warnings generated by the stall warning system and explain how these warnings can be cancelled.

#### **44.30 Windshear warning system**

44.30.2 Describe the function of the predictive windshear warning system.

44.30.4 Explain the principle of operation of a windshear warning system.

44.30.6 Identify the inputs of a windshear warning system.

44.30.8 State the purpose of pitch limit indicator bars.

44.30.10 Explain the limitations of the predictive windshear warning system.

### **Recorder Systems**

#### **44.32 Cockpit voice recorder**

44.32.2 Explain the purpose of the cockpit voice recorder.

44.32.4 List the components of the cockpit voice recorder.

44.32.6 Identify the power source of the CVR.

44.32.8 Explain how a cockpit voice recording is started and stopped.

44.32.10 Explain how recordings can be erased.

44.32.12 State the normal recording time of the voice recorder.

#### **44.34 Flight data recorder**

44.34.2 Explain the purpose of the flight data recorder.

44.34.4 Describe the parameters that are recorded by the flight data recorder.

44.34.6 Identify the power source of the FDR.

44.34.8 Explain the relation between the flight recorder and the Aircraft Integrated Data System.

44.34.10 Describe how data from the flight maintenance recorder can be accessed.

#### **Navigation Aids**

#### **44.36 Flight management system (FMS)**

44.36.2 Describe the two primary functions of a FMS.

44.36.4 Describe the main components of an FMS.

44.36.6 Explain the operating principle of an FMS.

44.36.8 Explain the function and operating principle of the attitude heading reference system (AHRS).

44.36.10 Explain how pilots interface with an FMS.

44.36.12 Describe the inputs the FMS accesses to achieve the navigation function.

44.36.14 Explain how the FMS achieves its performance functions in the various modes.

44.36.16 Explain the function and operating principle of the thrust management computer.

44.36.18 Explain how the flight guidance functions are achieved.

44.36.20 Describe how the FMS functions are monitored.

#### **44.38 Ring laser gyro**

44.38.2 Describe a ring laser gyro and compare it with a conventional gyro.

44.38.4 With the aid of a diagram, explain the principle of operation of a ring laser gyro.

44.38.6 State the pilot checks for serviceability.

#### **44.40 Inertial navigation/reference system (INS/IRS)**

44.40.2 Explain the function and basic operating principle of an inertial navigation/reference system (INS/IRS).

44.40.4 Explain the differences between an INS and an IRS.

44.40.6 Describe the inputs and output signals of an INS/IRS.

44.40.8 Identify the components of an INS/IRS.

44.40.10 Explain the conditions to be fulfilled when align mode is selected.

44.40.12 Explain the function of a gyro stabilised platform.

- 44.40.14 Explain the use of accelerometers in a gyro stabilised platform.
- 44.40.16 Describe how accelerations are integrated to derive velocity and distance.
- 44.40.18 Describe the differences between a gyro stabilised platform and a strapdown system.
- 44.40.20 State the advantages of a strapdown IRS over gyro stabilised INS.
- 44.40.22 State the purpose of the strapdown system.
- 44.40.24 Identify the types of gyro which are typically used for a strapdown system.
- 44.40.26 Explain how magnetic north is calculated.
- 44.40.28 Describe the limitations of a north referenced INS in polar regions.
- 44.40.30 Explain the principle of position updating by reference to ground stations or GNSS.

**44.42 Lateral (LNAV) and vertical (VNAV) navigation systems**

- 44.42.2 Explain the purpose of the LNAV and VNAV components of a flight management system.
- 44.42.4 Explain the basic operating principles of LNAV and VNAV.
- 44.42.6 Describe the inputs to LNAV and VNAV.
- 44.42.8 Describe the outputs of LNAV and VNAV.
- 44.42.10 Describe the operating modes of VNAV.
- 44.42.12 Describe the limitations of LNAV and VNAV.

**FANS (CNS/ATM)**

**44.44 Communications**

- 44.44.2 Explain the function and basic operating principle of each of the following:
  - (a) Aircraft Communications Addressing and Reporting System (ACARS).
  - (b) Controller Pilot Data Link Communications (CPDLC).
  - (c) Satellite Communications (SATCOM).
- 44.44.4 Describe the typical inputs to and outputs of each of the following:
  - (a) Aircraft Communications and Reporting System (ACARS).
  - (b) Controller Pilot Data Link Communications (CPDLC).
  - (c) Satellite Communications (SATCOM).
- 44.44.6 Describe limitations of each of the following:
  - (a) Aircraft Communications and Reporting System (ACARS).
  - (b) Controller Pilot Data Link Communications (CPDLC).
  - (c) Satellite Communications (SATCOM).

**44.46            Navigation Capability Requirements**

44.46.2           Describe the navigation capability requirements of the following types of airspace:

- (a) Required Navigation Performance 4 (RNP4) airspace.
- (b) Required Navigation Performance 10 (RNP10) airspace.
- (c) Basic Area Navigation (B-RNAV) airspace.
- (d) Minimum Navigation Performance Specification (MNPS) airspace.
- (e) Precision Area Navigation (P-RNAV) airspace.
- (f) RNAV procedural (terminal) airspace.

**44.48            Surveillance**

44.48.2           Explain the function and basic operating principle of each of the following:

- (a) Automatic Dependent Surveillance - Broadcast (ADS-B).
- (b) Automatic Dependent Surveillance - Contract (ADS-C).
- (c) Multilateration.

44.48.4           Describe the inputs to and outputs of each of the following:

- (a) Automatic Dependent Surveillance - Broadcast (ADS-B).
- (b) Automatic Dependent Surveillance - Contract (ADS-C).
- (c) Multilateration.

44.48.6           Describe limitations of each of the following:

- (a) Automatic Dependent Surveillance - Broadcast (ADS-B).
- (b) Automatic Dependent Surveillance - Contract (ADS-C).
- (c) Multilateration.