

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 Define Mach number and associated computational formulae.
- 44.2.4 Explain the principle of operation of a Machmeter.
- 44.2.6 Explain the following errors affecting a Machmeter:
 - (a) instrument
 - (b) position (pressure) error and
 - (c) lag.
- 44.2.8 Explain the following for blockages and leaks on the Machmeter:
 - (a) symptoms
 - (b) effects
 - (c) possible remedies

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 inputs, outputs and the supplied units of a digital ADC.
- 44.4.8 Explain the backup functions of the air data computer in the case of a pressure source blockage.

44.6 Air temperature gauge

- 44.6.2 Explain the principle of operation of an air temperature probe.
- 44.6.4 Define the following temperatures:
 - (a) Total Air Temperature (TAT)
 - (b) Static Air Temperature (SAT)
 - (c) Outside Air Temperature (OAT).
- 44.6.6 Compare the following temperatures:
 - (d) Total Air Temperature (TAT)
 - (e) Static Air Temperature (SAT)
 - (f) Outside Air Temperature (OAT).
- 44.6.8 Calculate the SAT, given indicated OAT, probe recovery factor and Mach number.
- 44.6.10 Calculate SAT given TAT and Mach number.

Integrated Flight Instrument Systems

44.8

Auto flight systems

- 44.8.2 Describe the function of a:
- (a) Flight Director (FD) system.
 - (b) Automatic Flight Control system (AFCS).
- 44.8.4 Interpret the information provided by the split cue and integrated cue flight director command bars.
- 44.8.6 Explain the function of the flight mode annunciator.
- 44.8.8 Explain the operating principle of a:
- (a) Flight Director system.
 - (b) Automatic Flight Control system.
- 44.8.10 Explain the use of the AFCS control panel.
- 44.8.12 Explain the operational modes available on an AFCS.
- 44.8.14 For an AFCS, describe the associated:
- (a) inputs
 - (b) controls
 - (c) indications
 - (d) warnings.
- 44.8.16 Explain the principle of operation of an autoland system.
- 44.8.18 Explain the meaning of:
- (a) fail operational
 - (b) fail passive
 - (c) alert height.
- 44.8.20 Explain the autoland systems component failure management.
- 44.8.22 Explain the principle of operation of flight envelope protection.
- 44.8.24 For a flight envelope protection installation, describe the associated:
- (a) inputs
 - (b) indications
 - (c) warnings.
- 44.8.26 Describe the function of the automatic trim system.

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 Describe the switching options in case of EFIS display failure.

- 44.10.12 Describe the function of the Primary Flight Display (PFD).
- 44.10.14 Identify the information available on the PFD.
- 44.10.16 Describe the colour coding on the PFD.
- 44.10.18 Describe the function of the Navigation Display (ND).
- 44.10.20 Name the typical display modes for ND.
- 44.10.22 Given suitable diagrams of instrument presentation, use a ND to determine an aircraft's track, position and/or orientation.
- 44.10.24 Given suitable diagrams identify the information available in the different modes of the ND.
- 44.10.26 Describe the colour coding on a typical ND.
- 44.10.28 Explain the operating principle of a Head-Up-Display (HUD).
- 44.10.30 Describe the inputs available to a Head-Up-Display (HUD).
- 44.10.32 Identify the information on a Head-Up-Display (HUD).
- 44.10.34 Explain the operating principle of an Enhanced Vision System.
- 44.10.36 Explain the operating principle of a Synthetic Vision System.

44.12 Electronic engine displays (ECAM, EICAS)

- 44.12.2 Explain the purpose of the Engine Indication and Crew Alerting System (EICAS).
- 44.12.4 Explain the purpose of the Electronic Centralized Aircraft Monitoring (ECAM) system.
- 44.12.6 Describe the information available from an ECAM/EICAS system.
- 44.12.8 Describe the display units (DU) of ECAM/EICAS System.
- 44.12.10 Interpret the primary colours used on 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 Describe the inhibiting of alerts during various phases of flight, including engine start, takeoff and landing.

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.

44.18 Radio (Radar) altimeter

- 44.18.2 State the function of a radio altimeter (RA).
- 44.18.4 Explain the principle of operation of the radio altimeter.
- 44.18.6 State the purpose of the decision height indication.
- 44.18.8 State the range of RA indication.
- 44.18.10 List instruments or units which receive altitude information from the radio altimeter.
- 44.18.12 State the reason for a wide sweep of frequencies.
- 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.
- 44.20.8 Describe, in simple terms, the TAWS 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”.
- 44.24 Takeoff configuration warning system**
- 44.24.2 Explain the purpose of a takeoff configuration warning system.
- 44.24.4 Explain the operating principle of a takeoff 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 State 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 and indications generated by the stall warning system and explain how these warnings can be cancelled.
- 44.28.12 State the purpose of pitch limit indicator bars.
- 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 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 Explain how a cockpit voice recording is started and stopped.
- 44.32.8 Explain how recordings can be erased.
- 44.32.10 State the regulatory minimum recording time of the CVR in NZ.

44.34 Flight data recorder

- 44.34.2 Explain the purpose of the digital flight data recorder (FDR/DFDR).
- 44.34.4 Describe the parameters that are recorded by the flight data recorder.
- 44.34.6 Describe actions to be taken to preserve the CVR/FDR in the event of an incident/accident.
- 44.34.8 Describe how data from the flight maintenance recorder can be accessed.
- 44.34.10 State the regulatory minimum recording time of the DFDR in NZ.

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.
- 44.36.10 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.
- 44.36.18 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.

44.40 Inertial reference system (IRS)

- 44.40.2 Explain the function and basic operating principle of an inertial reference system (IRS).
- 44.40.4 Describe the differences between a gyro stabilised platform and a strapdown system.
- 44.40.6 Explain the differences between an INS and an IRS.
- 44.40.8 Describe the inputs and output signals of an IRS.
- 44.40.10 Identify the components of an IRS.
- 44.40.12 Explain the conditions to be fulfilled when align mode is selected.
- 44.40.14 Explain the use of accelerometers in an IRS.
- 44.40.16 Describe how accelerations are integrated to derive velocity and distance.

- 44.40.18 State the advantages of a strapdown IRS over gyro stabilised INS.
- 44.40.20 Identify the types of gyro which are typically used for a strapdown system.
- 44.40.22 Explain how magnetic north is calculated.
- 44.40.24 Describe the limitations of a north referenced IRS in polar regions.
- 44.40.26 Describe the errors inherent in an IRS.
- 44.40.28 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 operating modes of LNAV and VNAV.
- 44.42.8 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)
 - (d) Selective calling (SELCAL).
- 44.44.4 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 Performance Based Navigation

- 44.46.2 Describe Performance Based Navigation (PBN).
- 44.46.4 Describe the following elements of PBN:
- (a) The Navigation Specification
 - (b) The Navaid Infrastructure
 - (c) The Navigation Application.
- 44.46.6 Explain the meaning of the following:
- (a) RNAV
 - (b) RNP
 - (c) AR
 - (d) ANP
 - (e) EPU
 - (f) Total System Error (TSE)
 - (g) LPV
 - (h) Fly-by waypoints
 - (i) Fly-over waypoints
 - (j) Track to fix (TF)
 - (k) Direct to fix (DF)
 - (l) Course to fix (CF)
 - (m) Radius to fix (RF).

- 44.46.8 Differentiate between RNAV and RNP navigation specifications.
- 44.46.10 Describe the following Navigation capability designations:
- (a) Area Navigation (RNAV) airspace
 - (b) Required Navigation Performance (RNP-4) airspace
 - (c) Required Navigation Performance (RNP-10) airspace
 - (d) Basic Area Navigation (B-RNAV) airspace
 - (e) Minimum Navigation Performance Specification (MNPS) airspace
 - (f) RNAV procedural (terminal) airspace.
- 44.46.12 Describe the construction of a PBN containment area.
- 44.46.14 Explain where the various navigation specifications are applied.
- 44.46.16 Describe the various GNSS based RNAV augmentations systems.
- 44.46.18 Describe the GPS (GNSS) Landing System (GLS).
- 44.46.20 Describe the extent of Reduced Vertical Separation Minimum (RVSM) airspace.
- 44.46.22 Explain the requirements for operating in Reduced Vertical Separation Minimum (RVSM) airspace.
- 44.46.24 Describe Strategic Lateral Off-Set Procedures (SLOP).
- 44.46.26 Explain the requirements for implementing Strategic Lateral Off-Set Procedures (SLOP) in airspace where this is permitted.

44.48 Surveillance

- 44.48.2 Explain the function of each of the following:
- (a) Automatic Dependent Surveillance - Broadcast (ADS-B)
 - (b) Automatic Dependent Surveillance - Contract (ADS-C)
 - (c) Multilateration.
- 44.48.4 Explain the basic operating principle of each of the following:
- (d) Automatic Dependent Surveillance - Broadcast (ADS-B)
 - (e) Automatic Dependent Surveillance - Contract (ADS-C)
 - (f) Multilateration.
- 44.48.6 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.
- 44.48.8 Describe limitations of each of the following:
- (a) Automatic Dependent Surveillance - Broadcast (ADS-B).
 - (b) Automatic Dependent Surveillance - Contract (ADS-C).
 - (c) Multilateration.