Subject No 56 Instruments and Navigation Aids

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 feed back to the examination candidate.

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

56.2 Pressure Instruments

56.2.2 Define, and distinguish between the following:

(a) static pressure;

(b) dynamic pressure; and,

(c) total (or pitot) pressure.

56.2.4 With the aid of diagrams:

(a) identify the elements of a basic pitot-static system;

(b) distinguish between separate pitot probe/static vents, and a combined pitot-static probe;

(c) label the basic elements of a typical pitot-static probe; and,

(d) state the precautions to be taken with pitot heat and pitot covers.

56.2.6 Describe position error.

56.2.8 With respect to the airspeed indicator (ASI) and, where appropriate, with the aid of diagrams or charts:

(a) explain the basic principle of operation;

(b) identify the markings on a typical light twin-engine aeroplane ASI;

(c) state the relationship between indicated, calibrated, equivalent and true airspeeds (IAS, CAS, EAS and TAS);

(d) state the errors affecting the ASI;

(e) explain the effect of blockages and leaks, and the remedies available to the pilot; and,

(f) state the serviceability checks.

56.2.10 With respect to the altimeter and, where appropriate, with the aid of diagrams:

(a) explain the basic principle of operation;

(b) describe the use of the altimeter settings QNH, QFE and QNE;

(c) describe the errors affecting the instrument;

(d) explain the effect of blockages and leaks, and the remedies available to the pilot; and,

(e) state the serviceability checks.

56.2.12 With respect to the vertical speed indicator (VSI) and, where appropriate, with the aid of diagrams:

(a) explain the basic principle of operation;

(b) describe the errors affecting the instrument;

(c) explain the effect of blockages and leaks; and,

(d) state the serviceability checks.

56.4 Gyroscopic Instruments

56.4.2 Describe the gyroscopic principles of rigidity and precession.

56.4.4 Define the four classes of gyroscope (space, tied, earth, and rate).

56.4.6 Describe, and make a comparison between pneumatic and electrical gyroscopic instrument power sources.

56.4.8 Describe, and differentiate between real and apparent wander.

56.4.10 With respect to the turn indicator/turn coordinator and, where appropriate, with the aid of diagrams:

(a) differentiate between the instrument presentations;

(b) explain the basic principle of operation;

(c) describe the errors affecting the instrument;

(d) explain the principle and use of the coordination ball; and,

(e) state the serviceability checks.

56.4.12 With respect to the heading/direction indicator (HI/DI) and, where appropriate, with the aid of diagrams:

(a) describe the basic principle of operation;

(b) describe the errors affecting the instrument (including apparent drift); and,

(c) state the serviceability checks.

56.4.14 With respect to the attitude indicator (AI) and, where appropriate, with the aid of diagrams:

(a) describe the basic principle of operation (for both air-driven and electrically driven instruments);

(b) describe the operation and function of the pendulous unit;

(c) describe the operation and function of the torque motor/levelling switch erection systems;

(d) describe the errors affecting the instrument; and,

(e) state the typical limits in freedom.

56.6 Compasses

56.6.2 Describe the earth's magnetic field and describe:

(a) magnetic dip, and components H and Z; and,

(b) variation.

56.6.4 With respect to direct-reading magnetic compasses and, where appropriate, with the aid of diagrams:

(a) explain how dip is compensated for;

(b) explain acceleration and turning error;

(c) define deviation; state how it is compensated for, and how correction can be made for residual deviation; and

(d) state the serviceability checks.

56.6.6 With respect to remote-indicating compasses and, where appropriate, with the aid of diagrams explain the basic principle of operation:

(a) describe the compass card presentation on the radio magnetic indicator (RMI);

(b) describe interpretation of the annunciator, and the operation of the compass synchronising knob of the RMI; and,

(c) explain the errors which can affect remote indicating compasses (including deviation), and how these can be avoided or reduced.

56.8 Basic Radio Principles

56.8.2 Describe the basic features of electromagnetic radiation.

56.8.4 Describe where radio waves exist within the electromagnetic spectrum.

56.8.6 With respect to radio waves and, where appropriate, with the aid of diagrams define:

(a) cycle;

(b) frequency, and state the unit describing frequency;

(c) wavelength, and explain how it is related to frequency;

(d) amplitude;

(e) attenuation;

(f) phase; and,

(g) phase difference.

56.8.8 Calculate frequency, given wavelength.

56.8.10 Calculate wavelength, given frequency.

56.8.12 Describe polarisation of a radio signal and its relationship to the orientation of transmission and receiving aerials.

56.8.14 Explain modulation of a carrier wave, and with the aid of diagrams, distinguish between amplitude modulation (AM) and frequency modulation (FM).

56.8.16 State the relative advantages and disadvantages of AM and FM.

56.8.18 Describe single sideband (SSB) and state the advantages and disadvantages in its use.

56.8.20 Describe the following types of radio wave propagation:

(a) surface waves, and the effect of diffraction (scattering) and wave tilting;

(b) sky waves, including the effect of frequency, critical angle, skip distance and dead spaces; and,

(c) direct waves, and the rule-of-thumb formula for calculating maximum range of reception.

56.8.22 Briefly describe the effects of static and atmospheric attenuation.

56.8.24 Explain the relationship between frequency and refraction in the ionosphere.

56.8.26 Describe the changes to the height of the ionosphere at night and the effect of this change on the optimum useable HF frequencies.

56.8.28 Explain the optimum useable frequency of an HF signal.

56.10 Primary Surveillance Radar (PSR)

56.10.2 Explain the principle of operation of PSR, including:

(a) the frequency bands/wavelengths typically used; and,

(b) the principles of radar ranging and direction.

56.10.4 Explain the factors affecting the operational range of PSR.

56.10.6 State the maximum range of PSR in New Zealand.

56.10.8 Explain the factors which effect the minimum and maximum range of a primary radar system.

56.10.10 Describe the limitations in the operational use of PSR.

56.12 Secondary Surveillance Radar (SSR)

56.12.2 Explain the principle of operation of SSR.

56.12.4 Distinguish between primary surveillance radar (PSR) and secondary surveillance radar (SSR).

56.12.6 Describe the advantages and disadvantages of SSR over PSR.

56.12.8 Explain the factors affecting the operational range of SSR.

56.12.10 State the maximum operational range of the SSR system in New Zealand.

56.14 Transponders

56.14.2 Distinguish between Mode A and Mode C transmissions from a transponder, and describe the following functions on a typical transponder control panel:

(a) standby (SBY);

(b) ON;

(c) ALT;

(d) test (TST);

(e) code selection controls; and,

(f) reply monitor light.

56.14.4 Describe the correct use of the IDENT button (or switch).

56.14.6 Explain the meanings of typical transponder terminology.

56.14.8 State the operational limits of Mode C readouts.

56.14.10 State the transponder emergency codes.

56.14.12 Describe the operation precautions required when changing codes.

56.16 Airborne Weather Radar

56.16.2 Explain the principle of operation of airborne weather radar.

56.16.4 State the frequency band used in an airborne weather radar, and explain why this band is used.

56.16.6 Describe the function of:

(a) the tilt control;

(b) the range control;

(c) the ANT STAB switch; and,

(d) the GAIN control.

56.16.8 Interpret the indications from a weather radar, in its various modes.

56.16.10 Describe the weather radar return strengths of various types of precipitation.

56.16.12 Describe the advantages of a narrow beam in a primary pulsed radar system.

56.16.14 Explain the advantages of Doppler Weather Radar.

56.18 Visual Landing Aids

56.18.2 Describe the purpose of approach lighting systems and distinguish between the three types of system commonly used in New Zealand.

56.18.4 Describe the purpose of circling guidance lighting and runway lead-in lighting.

56.18.6 Given suitable diagrams, interpret the approach slope indications given by the following systems.

(a) T-VASIS;

(b) RAE red-white VASIS; and,

(c) precision approach path indicator (PAPI) and abbreviated PAPI.

56.18.8 Explain the standard PAPI angle setting, and the setting of PAPI threshold crossing height (TCH).

56.18.10 State the possible atmospheric effects on approach slope indication.

56.18.12 Describe typical layout and presentation of the following lighting:

(a) normal runway;

(b) displaced threshold;

(c) runway touchdown zone;

(d) runway end indicator lighting;

(e) taxiway;

(f) wind direction aerodrome beacons;

(g) obstruction lighting; and,

(h) aeronautical/marine beacons.

56.18.14 Describe pilot activated lighting (PAL) and the standard system of keying PAL.

56.18.16 Describe the means available for remote control of lighting other than PAL.

56.20 NDB and ADF

56.20.2 Describe the basic features of a non directional beacon (NDB), including:

(a) the range of frequencies usually employed;

(b) the factors affecting operational range; and,

(c) typical name, frequency, identification and location details.

56.20.4 Describe the basic components of an aircraft automatic direction finder (ADF).

56.20.6 Explain the basic principles of loop direction finding, including the:

(a) generation of maximum and null signals in different loop positions;

(b) use of polar diagrams;

(c) application of a sense aerial to resolve ambiguity; and,

(d) automatic seeking of the null position (hence ADF).

56.20.8 Describe the basic principle of operation of a fixed loop, and state the advantages a fixed versus rotating loop.

56.20.10 State the importance, when tuning an NDB, of making a positive identification of the station tuned, and of checking proper functioning of the ADF.

56.20.12 Describe the function of the controls on a typical ADF control panel, including:

(a) ANT (or REC or VOICE) mode;

(b) ADF (or COMP) mode;

(c) TEST mode;

(d) BFO (or CW); and,

(e) the LOOP position, where fitted.

56.20.14 Given suitable diagrams of instrument presentation, describe the use of a relative bearing indicator (RBI), a rotatable card ADF, and a radio magnetic indicator to determine:

(a) magnetic bearing to an NDB (orientation);

(b) position in relation to required track to/from an NDB;

(c) interception of a required track to/from an NDB; and,

(d) station passage.

56.20.16 Explain the following factors which affect the accuracy of ADF indications:

(a) night effect;

(b) coastal refraction;

(c) mountain effect; and,

(d) precipitation static and thunderstorms.

56.22 VOR

56.22.2 Explain the basic operating principles of a VOR ground station, including the:

(a) reference phase signal;

(b) variable phase signal; and,

(c) measurement of phase difference.

56.22.4 Given suitable diagrams, explain the operation of a typical VOR indicator, including:

(a) radials, and the use of the omni-bearing selector (OBS);

(b) the course deviation indicator (CDI); and,

(c) the TO/FROM indicator.

56.22.6 Given suitable diagrams of VOR presentation (including RMI and HSI presentation), demonstrate its use for:

(a) orientation;

(b) crossing a radial and station passing;

(c) maintaining track on a radial; and,

(d) intercepting radials inbound and outbound.

56.22.8 Discuss the factors affecting range and accuracy of VOR, including:

(a) maximum range, published route operating limitations; and,

(b) errors, particularly terrain effect error with “scalloping” and “radial bending”.

56.24 Distance Measuring Equipment (DME)

56.24.2 Describe the basic principle of operation of DME.

56.24.4 Explain the operation of a typical DME controller, including:

(a) tuning with a paired VOR or ILS frequency;

(b) tuning directly to a DME frequency;

(c) DME ident;

(d) indication of signal loss;

(e) saturation;

(f) tuning a VORTAC frequency.

56.24.6 Explain and calculate the following:

(a) design maximum range;

(b) expected maximum range at different altitudes; and,

(c) DME distance (slant range) versus horizontal range.

56.26 Instrument Landing System (ILS)

56.26.2 Explain the basic principle of operation of an instrument landing system **(**ILS), including:

(a) localiser principles; standard rated coverage, and CDI indication;

(b) glideslope principles; angle, and indication; and,

(c) marker beacons, indication of passage.

56.26.4 State the localiser and glideslope displacement represented by full scale deviation of the CDI and glideslope indicators.

56.26.6 State the rule-of-thumb methods of calculating:

(a) required height above threshold for a 3° glideslope; and,

(b) rate of descent required to maintain a 3° glideslope at any given groundspeed.

56.26.8 Given suitable diagrams of instrument presentation, interpret aircraft position with
respect to ILS centreline and glideslope.

56.28 Global Navigation Satellite System (GNSS/GPS)

56.28.2 State the three main elements of the GNSS (GPS) system.

56.28.4 Describe the GNSS satellite constellation including:

(a) frequency used for transmissions;

(b) types of pseudo-random code;

(c) GNSS time reference;

(d) ephemeris;

(e) almanac.

56.28.6 Outline the elements of the control segment.

56.28.8 Describe the user segment, including the basic principle of satellite ranging.

56.28.10 Explain the principles of fixing position using the GNSS system; including:

(a) the number of satellites required for 2D and 3D fixing;

(b) elimination of clock error;

(c) the operation of RAIM;

(d) PDOP/GDOP;

(e) barometric aiding; and,

(f) receiver masking function.

56.28.12 Explain how the receiver predicts the position of various satellites.

56.28.14 State the sources of GNSS error, and the maximum error which could be expected with and without selective availability applied.

56.28.16 State the reasons for the display of a RAIM warning message, and the requirements under CAA Rules for continued navigation.

56.28.18 Explain the operation of the RAIM prediction service.

56.28.20 Describe the application of the WGS 84 datum, and the likely effects on the GPS display of using coordinates from another datum.

56.28.22 Explain the principle of operation of Differential GPS (DGPS).