Advisory Circular

AC66-2.14

Original

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Aircraft Maintenance Engineer Licence — Examination Subject 14 Instrument Systems

General

Civil Aviation Authority Advisory Circulars contain information about standards, practices, and procedures that the Director has found to be an **Acceptable Means of Compliance (AMC)** with the associated rule.

An AMC is not intended to be the only means of compliance with a rule, and consideration will be given to other methods of compliance that may be presented to the Director. When new standards, practices, or procedures are found to be acceptable they will be added to the appropriate Advisory Circular.

An Advisory Circular may also include **guidance material (GM)** to facilitate compliance with the rule requirements. Guidance material must not be regarded as an acceptable means of compliance.

Purpose

This Advisory Circular provides an AMC for the syllabus content in respect of written examinations for Subject 14 (Instrument Systems).

This Advisory Circular also provides GM for recommended study material in respect of the examination syllabus in this Advisory Circular.

Related Rules

This Advisory Circular relates specifically to Civil Aviation Rule Part 66 Subpart B — Aircraft Maintenance Engineer Licence.

General information on Aircraft Maintenance Engineer Licence (AMEL) examination requirements is contained in Advisory Circular AC66-1.

Change Notice

No change.

Table of Contents

Rule 66.57 Eligibility Requirements

Rule 66.57(a)(2) requires an applicant for an AMEL to have passed written examinations, that are acceptable to the Director, and relevant to the duties and responsibilities of an aircraft maintenance engineer in the category of licence sought.

The written examinations acceptable to the Director for Subject 14 (Instrument Systems) should comply with the syllabus contained in this Advisory Circular. Each examination will cover all topics and may sample any of the sub-topics.

The new syllabus has been developed after extensive industry consultation and the objectives reflect the knowledge required of current technology and international best work practice.

Examination Overview: Subject 14

The pass mark for Subject 14 (Instrument Systems) is 75%.

Application to sit an examination may be made directly to Aviation Services Limited (ASL). Refer to http://caanz.aspeqexams.com/ for examination information.

General Examining Objective

The objective of the examination is to determine that the applicant for an AMEL has adequate knowledge of Instrument Systems to permit the proper performance, supervision and certification of aircraft maintenance at a level commensurate with the privileges of the various AMEL categories.

Knowledge Levels

LEVEL 1: A familiarisation with the principal elements of the subject.

Objectives: The applicant should:

1. be familiar with the basic elements of the subject.
2. be able to give simple descriptions of the whole subject, using common words and examples.
3. be able to use typical terms.

LEVEL 2: A general knowledge of the theoretical and practical aspects of the subject.

An ability to apply the knowledge.

Objectives: The applicant should:

1. be able to understand the theoretical fundamentals of the subject.
2. be able to give a general description of the subject using, as appropriate, typical examples.
3. be able to use mathematical formulae in conjunction with physical laws describing the subject.
4. be able to read and understand sketches, drawings and schematics describing the subject.
5. be able to apply his/her knowledge in a practical manner using detailed procedures.

LEVEL 3: A detailed knowledge of the theoretical and practical aspects of the subject.

A capacity to combine and apply the separate elements of knowledge in a logical and comprehensive manner.

Objectives: The applicant should:

1. know the theory of the subject and the interrelationships with other subjects.
2. be able to give a detailed description of the subject using theoretical fundamentals and specific examples.
3. understand and be able to use mathematical formulae related to the subject.
4. be able to read, understand and prepare sketches, simple drawings and schematics describing the subject.
5. be able to apply his/her knowledge in a practical manner using manufacturer's instructions.
6. be able to interpret results and measurements from various sources and apply corrective action where appropriate.

Recommended Study Material

The publication list below provides guidance material for suitable study references for the overall syllabus content. However, applicants may have to conduct further research using other references or sources (including the internet) or attend a formal course in order to gain a comprehensive understanding of all sub-topics in the syllabus.

Publication references have not been assigned to individual topics in this syllabus.

Publication List

Study Ref	Book Title	Author	ISBN
1	Aircraft Instruments and Integrated Systems	EHJ Pallett	0-582-08627-2
2	Avionic Systems Operation and Maintenance	James W. Wasson	0-89100-436-X
3	Avionics Fundamentals	Jeppesen	0-89100-293-6
4	Aircraft Instruments and Avionics for A & P Technicians	Jeppesen	0-89100-422-X

Syllabus Layout

Topic Numbering – left hand column

The syllabus is set out by topics, each of which is identified by a single-digit number. Each topic is divided into a number of sub-topics, which are identified by two-digit numbers: the first and second digits of which refer to the topic and the sub-topic respectively.

Each sub-topic is further sub-divided into one or more sub-sub-topics, which are identified by three-digit numbers. Where applicable, sub-sub-topics may be further subdivided into paragraphs that are identified by four/five digit alphanumeric sequences.

The three-digit sub-sub-topic numbers shown in the left hand column are used in the ‘knowledge deficiency reports’ to provide feedback on individual examinations.

Objective description – middle column

The middle column objectively describes each sub-sub-topic by stating, in plain language, its subject matter and the type of performance or activity required. The objectives are intended to be simple, unambiguous, and clearly-focussed, outcomes to aid learning.

Knowledge levels – right hand column

The right hand column specifies the knowledge level for each sub-topic heading. The three levels of knowledge used in this syllabus are described above. Note that the knowledge levels indicate the depth of knowledge required NOT its safety importance.

Syllabus: Subject 14 (Instrument Systems)

1	**Basic Aircraft Instrument Systems**	
1.1	**Pitot Static Systems**	
1.1.1	In relation to pitot static systems, describe the following: a. Pitot static leak tests as required in NZ CAR and AC b. Pressure (position)error and its effects on pitot static instruments c. Terms related to pitot static systems d. Construction and operation of pitot, pitot/static probes and static vents (both primary and alternate) e. The layout of a typical pitot static system with particular regard to the identification and placement of components. f. The CAR requirements relating to the testing of instruments in VFR and IFR aircraft. g. Maintenance of pitot static systems.	2
1.2	**Altimeters**	
1.2.1	Describe the following altimeter related conditions/terms: a. After effect b. Friction c. Scale error d. Barometric scale error	2
1.2.2	Describe the tests for altimeters as laid down in NZCAR and ACs.	2
1.2.3	Describe the construction, operation and function of typical altitude alerting and reporting systems including encoding altimeters.	
1.3	**Air Speed Indicators**	
1.3.1	Define the following terms and describe how they are affected by various factors: a. Mach number b. Critical mach number c. Maximum mach operation (MMO) d. Sonic e. Subsonic f. Transonic g. Supersonic h. Speed of sound i. Velocity maximum operating (Vmo)	2
1.3.2	Describe the tests for airspeed indicators as laid down in NZCAR.	2

1.4	**Air Data Computers and Servo Altimeters**	
1.4.1	Describe the layout of a typical air data computer system.	2
1.4.2	Describe the fundamental principles of operation of a typical air data computer system.	2
1.4.3	List the inputs and outputs for a typical air data computer.	1
1.4.4	Describe the construction, operation and function of total air temperature probes.	2
1.4.5	Describe the construction, operation and function of servo altimeters.	2
1.5	**Temperature Indicating Systems**	
1.5.1	Calculate the value of an unknown resistor in a balanced Wheatstone bridge circuit.	2
1.5.2	Define static air temperature and describe how it is measured.	2
1.5.3	Define total air temperature.	2
1.5.4	Describe the operation and construction of radiation pyrometer type temperature indicating systems.	2
1.6	**Fuel Flow and Basic Fuel Quantity Indicating Systems**	
1.6.1	Describe the construction and operation of a basic electronic type fuel quantity indicating system including: a. indicator. b. transmitter. c. power supply.	2
1.6.2	Describe the effect that changes in temperature have on fuel flow and quantity indicating systems.	2
1.6.3	Describe the adjustments that may be performed on fuel flow and quantity indicating systems.	2
1.6.4	Describe the operation and purpose of a densiometer installed in an aircraft fuel tank	2
1.6.5	Describe mandatory tests and calibrations that are performed on fuel flow and quantity indicating systems.	2

1.7	**DC Synchronous Systems and Engine Speed Indicating Systems**	
1.7.1	Describe the construction and operation of a DC Desyn system	2
1.7.2	Describe the construction and operation of a Selsyn system	2
1.7.3	Describe the construction and operation of mechanical engine speed indicating systems and their associated components.	2
1.7.4	Describe the construction and operation of electrical engine speed indicating systems and their associated components.	2
1.7.5	Describe the construction and operation of electronic engine speed indicating systems and their associated components.	2
1.7.6	Describe the calibration, adjustment, maintenance and trouble shooting of the above engine speed indicating systems.	2
1.8	**Engine Indicating Systems – Piston and Turbine Engines**	
1.8.1	Identify where the following instrument systems measurements are taken in respect of piston and gas turbine engines as appropriate: a. AC inductor oil pressure system gauges b. Ratiometer oil pressure system gauges c. Engine pressure ratio gauges d. Engine vibration systems e. Exhaust gas temperature gauges f. Manifold pressure gauges g. Torquemeters h. Turbine inlet temperature gauges	2
1.8.2	Describe the construction and operation of the following engine indicating system gauges: a. AC inductor oil pressure system gauges b. Ratiometer oil pressure system gauges c. Engine pressure ratio gauges d. Engine vibration systems e. Exhaust gas temperature gauges f. Manifold pressure gauges g. Torquemeters h. Turbine inlet temperature gauges	2
1.8.3	Describe the calibration, adjustment troubleshooting and maintenance of the following gauges: a. AC inductor oil pressure system gauges b. Ratiometer oil pressure system gauges c. Engine pressure ratio gauges d. Engine vibration systems e. Exhaust gas temperature gauges f. Manifold pressure gauges g. Torquemeters h. Turbine inlet temperature gauges	2
1.8.4	Define terminology relating to engine indicating systems.	2

1.9	**Head-up Displays**	
1.9.1	Describe the operation of, and the indications provided by a typical head-up display.	2
1.10	**Stall warning**	
1.10.1	Describe the construction and operation the following systems: a. Attack sensor b. Stick pusher c. Stick shaker	2

2	Gyroscopic Instrument Systems	
2.1	**Gyroscopic Principles**	
2.1.1	In respect to apparent precession, define earth rate and calculate it for various positions on the earth.	2
2.1.2	Describe gimbal lock and the gimbal layout for two and three gimbaled gyroscopes.	2
2.1.3	Describe real drift, apparent drift and list the factors that affect them.	2
2.1.4	Describe the precautions associated with the use and handling of gyroscopic instruments.	2
2.2	**Artificial Horizons**	
2.2.1	Describe the construction, operation and function of air driven artificial horizons.	2
2.2.2	Describe the construction, operation and function of electrically driven artificial horizons.	2
2.2.3	Identify and describe information displayed on artificial horizons.	2
2.2.4	Describe the following errors and methods used to overcome them: a. Acceleration b. Turn c. Erection	2
2.2.5	Describe the operation of the following erection systems: a. Ball type b. Levelling switch c. Pendulous vane d. Torque motor	2
2.2.6	Describe the reasons for fast erection, operation and precautions associated with the use of the system.	2
2.3	**Directional Gyros**	
2.3.1	Describe gimbal rebalancing and gimbal errors.	2
2.3.2	Describe the effect that the above errors have on the operation of the instrument.	2

3	Cockpit Display and Safety Monitoring Systems	
3.1	**Electronic Instrument and Information Display Systems**	
3.1.1	Describe construction purpose and operation of the following types of electronic instrument display: a. CRT b. LED c. LCD	2
3.1.2	Describe symbol generation and symbol generators in cockpit display systems.	2
3.1.3	Describe a typical electronic centralised aircraft monitoring system (ECAM) with particular regard to the following: a. Basic system operation b. A typical system layout c. Interpretation of information presented on an ECAM system	2
3.1.4	Describe a typical engine indicating and crew alerting system (EICAS) with particular regard to the following: a. Basic system operation b. A typical system layout c. Interpretation of information presented on an ECAM system	2
3.1.5	Describe a typical flight management system (FMS) with particular regard to the following: a. Basic system operation b. A typical system layout c. Interpretation of information presented on an ECAM system	2
3.1.6	Describe a typical electronic horizontal situation indicator (EHSI) with particular regard to the following: a. Basic system operation b. A typical system layout c. Interpretation of information presented on an ECAM system	2
3.1.7	Describe a typical electronic attitude direction indicator (EADI) with particular regard to the following: a. Basic system operation b. A typical system layout c. Interpretation of information presented on an ECAM system	2
3.1.8	Describe a typical head-up display and presentation.	2
3.1.9	Describe a typical moving map and flight tracking system.	2

3.2	**Ground Proximity Warning Systems (GPWS)**	
3.2.1	Describe the legal requirements for the installation of a GPWS in aircraft.	2
3.2.2	List the inputs required for the operation of a typical ground proximity warning system.	2
3.2.3	Describe the aircraft systems interfaces for a GPWS.	2
3.2.4	Describe the indications (visual and aural) provided by the system when a mode 1 to mode 5 (including sub-modes) situation is encountered.	2
3.2.5	Interpret the graphs associated with each GPWS mode and sub-mode.	1
3.2.6	Describe the operation of the GPWS when either of the OVERRIDE SWITCHES or the GLIDESLOPE INHIBIT switch is activated.	2
3.2.7	Describe to block diagram level, the operation of a GPWS.	2
3.2.8	Describe the differences between an enhanced GPWS (EGPWS) and a normal GPWS.	2
3.3	**Flight Data and Cockpit Voice Recording Systems**	
3.3.1	Describe the following criteria relating to flight data recorders: a. System requirements b. Operation c. Protection d. Installation	2
3.3.2	List and describe the relevance of the following mandatory parameters that must be monitored on a FDR system: a. Airspeed b. Magnetic heading c. Press to transmit (radio transceiver/event marker d. Pressure altitude e. Time f. Vertical acceleration	1
3.3.3	Describe the following methods of recording information: a. Trace recording b. Electromagnetic recording c. Semiconductor	2
3.3.4	Describe the purpose and function of the following system components: a. Encoding panel b. Signal conditioning unit c. Data acquisition unit	2
3.3.5	Describe how data is recovered, analysed and verified from FDR and CVR systems.	2
3.3.6	Describe the location requirements for a flight data and cockpit voice recording system.	2
3.3.7	Describe how FDR and CVR systems interface with other systems on an aircraft.	2

3.4	**Vibration Measurement**	
3.4.1	Describe the following criteria relating to on-board vibration monitoring and warning systems: a. Sensing devices b. Signal conditioning and process c. Display and indication d. Alarm levels e. Warning f. Helicopter vibration indicating systems (HUMS)	1

4	Fixed Wing Autopilots and Flight Directors	
4.1	**Definitions, Terminology and Power Operated Control Surfaces**	
4.1.1	Define the following terms associated with the theory of operation and use of automatic flight control and flight director systems: a. Authority b. Capture c. Couple d. Decision height e. Engaged f. Gain g. Single axis auto pilot h. Multi axis autopilot i. Wing leveller j. Auto-stabiliser k. Crosswind effect l. Washout m. Cone of confusion n. Versine generation and application	2
4.1.2	Describe and identify power assisted and power operated flight controls.	2
4.1.3	Describe the purpose and operation of “artificial feel” systems.	2
4.1.4	Describe the “q feel” method of achieving artificial feel and the factors that affect its operation.	2
4.2	**Fundamentals of Automatic Control**	
4.2.1	Describe the basic operation of an automatic flight control system and define the following: a. Inner loop stabilization b. Outer loop control	2
4.2.2	Describe the operation of a typical interlock circuit.	2
4.2.3	From given data troubleshoot a typical autopilot engage circuit.	2
4.2.4	Describe the operation and typical layout of a single axis (roll) AFCS.	2
4.2.5	Describe the purpose, advantages and disadvantages of control signal limiting and gain adjustment.	2
4.2.6	Describe the difference between power-assisted and power-operated flight controls.	2
4.2.7	Describe the methods by which roll and roll/yaw error signals are sensed in rate, displacement and inclined rate gyros.	2
4.3	**Attitude Change Signal Detection**	
4.3.1	Describe the operation of an autopilot system in providing for co-ordinated turns.	2
4.3.2	Describe the purpose and operation of versine generators and dynamic vertical sensors.	2
4.3.3	Describe the operation of moving vane and E and I bar sensors.	2

4.4	**Command Signal Processing/Turbulence Penetration**	
4.4.1	Describe the methods by which attitude changes are detected in roll, pitch and yaw.	2
4.4.2	Describe the purpose of, and methods of achieving the following signal processes within an autopilot system: a. Gain and adaptive control b. Limiting c. Synchronization	2
4.4.3	Describe the purpose, operation and layout of a control wheel steering system.	2
4.4.4	State the purposes and describe the operation of trim indicators.	1
4.4.5	Describe the effects of turbulence on the operation of the flight control system and describe how they are reduced or eliminated.	2
4.5.	**Modes of Operation – Roll, Pitch and Yaw Channels**	
4.5.1	Describe the method of selecting and the operation of the following roll channel modes: a. Basic stabilization b. Heading hold c. Turn command d. Very high frequency omni range (VOR)/localiser (LOC)	2
4.5.2	From given information, diagnose defects within a roll channel.	3
4.5.3	Describe the method of selecting and the operation of an autopilot in the following pitch channel modes: a. Altitude hold b. Basic stabilization c. Pitch command d. Vertical speed e. Airspeed f. Mach hold	2
4.5.4	From given information diagnose defects within a pitch channel.	3
4.5.5	Describe the operation of the yaw channel.	2
4.6	**Servomotors**	
4.6.1	Describe the construction and operation of the following types of servomotor: a. Duplex b. Electrohydraulic c. Electromechanical d. Electropneumatic	2
4.6.2	Specify the reasons for, and be able to describe the various methods of torque limiting.	2
4.6.3	Describe the differences between series and parallel-connected servomotors.	2

4.7	**Automatic Trim Control**	
4.7.1	State the reasons for, and describe the operation of, automatic pitch trim systems.	2
4.7.2	Define the function of flap compensation systems.	2
4.7.3	Describe how flap compensation is achieved.	2
4.7.4	Describe the purpose and operation of the mach trim system.	2
4.7.5	Describe the operation and function of alpha trim.	2
4.7.6	Describe the operation and function of centre or gravity trimmers.	2
4.8	**Yaw Damping**	
4.8.1	Describe the function of yaw damper systems.	2
4.8.2	Describe the layout of components in a yaw damper system.	2
4.8.3	Describe the operation of a yaw damper system.	2
4.8.4	Describe the relationship of a yaw damper system (parallel and series connected) with an autopilot. (including autopilot interlocks).	2
4.8.5	Describe the phenomenon of Dutch Roll.	2
4.8.6	Describe aileron and rudder control interaction during turns.	2

4.9	**Autopilot – Navigation Aids Interface**	
4.9.1	Describe the operation and function of the following navigation system inputs and their effects and interface with an autopilot: a. VOR b. LOC c. Glideslope d. Doppler e. Compass systems f. Inertial navigation	2
4.9.2	With regard to an instrument landing system (ILS) be able to: a. describe crosswind compensation b. describe the changes which occur within and autopilot system when operating in ILS c. interpret information displayed by course deviation bars, glideslope pointers, marker lights and system status flags d. state the approximate Beamwidth and angle of inclination of glideslope and localiser beams e. state the position of localiser, glideslope and marker transmitters in relation to the runway f. state the sequence in which glideslope and localiser signals are captured	2
4.9.3	Describe the composition of a VOR signal and describe how the airborne system identifies the station and calculates the bearing to that station,	2
4.9.4	Describe the cone of confusion and describe how an indicator is affected during a flight in this region.	2
4.9.5	List the factors that affect the indication s on a VOR.	1
4.9.6	Describe the purpose of an overstation sensor circuit.	2
4.9.7	Interpret VOR displayed information on a horizontal situation indicator (HIS)	1
4.10	**Flight Directors**	
4.10.1	Describe the construction and operation of an attitude direction indicator (ADI).	2
4.10.2	Describe the construction and operation of a horizontal situation indicator (HIS).	2
4.10.3	Interpret the presentation of information provided on an ADI and HIS when the system is operating in various modes.	1
4.10.4	Describe the layout and operation of a typical flight director system operating in various modes – coupled and uncoupled.	2
4.10.5	From information provided, indicate signal flows (to block and line level) and identify causes of malfunctions.	2
4.10.6	Describe the use of maintenance date to specification ATA 100 or 2100.	2

4.11	**Flight Director Displays and Cathode Ray Tubes**	
4.11.1	In relation to electronic flight instrument systems (EFIS) and using the listed references: a. Describe basic system operation b. Describe a typical system layout c. Interpret information presented	2
4.12	**Automatic Landing Systems**	
4.12.1	With regards to an automatic landing system (ILS), describe the following: a. System operation including inputs and outputs b. Category of operation c. Redundancy requirements	2
4.12.2	Define the following terms: a. Fail passive operation b. Fail operation c. Runway visual range	2
4.13	**Autothrottle Systems**	
4.13.1	Describe the operation of the Autothrottle system when operating in the following modes: a. Takeoff b. Speed control c. Go-round	2
4.13.2	Describe the interrelationship of the Autothrottle system with the AFCS and FMC	2
4.14	**Fly By Wire (FBW) Control Systems**	
4.14.1	Describe the advantages of FBW over the more conventional systems with particular regard to the following criteria: a. Weight saving b. Reduced maintenance c. Gust load alleviation d. Automatic manoeuvre envelope protection e. Improved handling f. Fuel saving	2
4.14.2	Describe the following associated terms: a. Active control b. Cross voting c. System architecture d. Force gradient	2
4.14.3	Describe how provision is made for “alternate” operation and how this improves redundancy.	2
4.14.4	Describe the use of “Control Laws” in providing roll and pitch control.	2
4.14.5	Describe the operation of “side stick” and “throttle levers”.	2

5	Helicopter Autopilots and Flight Directors	
5.1	**Fundamentals of Rotary Wing Auto Flight Control Systems (AFCS)**	
5.1.1	Describe the following terms and their interaction with each other: a. Air Density b. Angle of attack c. Axis of rotation or shaft axis d. Blade loading e. Centrifugal force f. Collective pitch g. Coning angle h. Cyclic pitch i. Feathering j. Lift thrust vector k. Pitch angle l. Relative airflow m. Thrust or vertical axis n. Tip path plane	2
5.1.2	Describe the relationship between the following: a. Lift b. Thrust c. Weight d. Drag e. CG Range	2
5.1.3	Describe the following terms and the relationship between each: a. Vortex ring state b. Power settling c. Over pitching	2
5.1.4	Describe torque reaction and its effect on directional control of the helicopter.	2
5.1.5	Describe gyroscopic precession and the use of this effect in providing control of the main rotor disc for forward, sideways and rearward flight.	2
5.1.6	Describe dissymmetry of lift and its control.	2
5.1.7	Describe coriolis effect and the features (such as lead/lag hinges and underslung rotor) used to relieve the stresses it creates.	2
5.1.8	Describe ground effect and translational lift and their relationship.	2
5.1.9	Describe translating tendency and its correction by mast offset and cyclic rigging.	2
5.1.10	Describe the reason for blade tip stall and why it results in nose pitch up of the helicopter.	2

5.2	**Helicopter Stability**	
5.2.1	Describe static and dynamic stability and why most helicopters are considered to be statically stable and dynamically unstable.	2
5.2.2	Describe how the inherent dynamic instability is overcome by the use of the following design methods: a. Stabilizer bar b. Offset flapping hinges c. Delta three hinges	2
5.2.3	Describe ground resonance, its causes and remedial action to be taken should it occur.	2
5.3	**Roll and Pitch Control**	
5.3.1	Describe the layout, purpose of components and the operation of a basic helicopter flight control system.	2
5.3.2	Describe the operation of the pitch and roll channels.	2
5.4	**Helicopter Yaw Control and Trim**	
5.4.1	Describe the operation purpose and layout of yaw channel.	2
5.4.2	Describe the purpose and operation of yaw and gravity trim systems.	2
5.5	**System Operation**	
5.5.1	Describe the operation of the helicopter automatic flight control system when operating in the following: a. Collective or power axis mode b. Coupled or instrument flight rules (IFR) c. Stability augmentation system ((SAS)	2
5.5.2	Diagnose faults in helicopter autopilot systems using given data and diagrams.	3
5.6	**Autopilot and Navigation Aids Interface**	
5.6.1	Explain the basic operation of a radio navigation system installed in a helicopter and its relationship with an auto flight system, with respect to the following: a. Glide slope b. Localizer c. Marker beacons d. VOR e. Instrument landing system (ILS)	3

5.7	**Helicopter Flight Director Systems**	
5.7.1	Describe the construction and operation of an attitude direction indicator (ADI).	2
5.7.2	Describe the construction and operation of a horizontal situation indicator (HSI).	2
5.7.3	Interpret the presentation of information provided on an ADI and HIS when the system is operating in various modes.	2
5.7.4	Describe the layout and operation of a typical flight director system operating in various modes – coupled and uncoupled.	2
5.7.5	From information provided, indicate signal flows (to block and line level) and identify causes of malfunctions.	2
5.7.6	Evaluate maintenance data to specification ATA 100 or ATA 2100.	3
5.8	**Flight Director Displays and Cathode Ray Tubes**	
5.8.1	In relation to electronic flight instrument systems (EFIS) and using the listed references: a. Describe basic system operation b. Describe a typical system layout c. Interpret information presented	2

6	Remote Indicating Compass Systems	
6.1	**System Architecture and Terminology**	
6.1.1	Describe the advantages of remote reading compasses over direct reading compasses.	2
6.1.2	In relation to remote reading compasses define and describe the following terms: a. Null b. Nutation c. Slaved d. Synchronised	2
6.1.3	Describe the operation of the flux valve detector element.	2
6.1.4	State the reasons why permalloy is used in the construction of a flux valves.	1
6.1.5	Describe the advantages of permalloy over iron in regard to the following factors: a. Permeability b. Saturation point c. Hysteresis curve d. Remanance e. Coercive force	2
6.2	**Flux Valves**	
6.2.1	Describe the construction, location and operation of a flux valve in determining the horizontal component of the earth's magnetic field.	2

6.3	**RR Compass System Operation**	
6.3.1	Describe the construction and layout of a typical remote indicating compass system to a block diagram level.	2
6.3.2	Describe the operation of a typical system in slaved and DG or free modes of operation.	2
6.3.3	Describe synchronisation, how a system is synchronised and indications provided when a system, is either in or out of synchronisation.	2
6.3.4	Describe the following errors: a. One cycle b. Two cycle c. Transmission d. Coriolis	2
6.3.5	Describe the effects that the above errors have on the indication of a compass.	2
6.3.6	Describe methods used to overcome each of the above errors in a compass system.	2
6.3.7	Describe the purpose and basic operation of the “spindown” brake system incorporated in some directional gyros (DG) elements of a remote reading compass system.	2
6.3.8	Describe the problems associated with navigating over the polar regions.	2
6.3.9	Describe the purpose and operation of the hemisphere switch and latitude selector in overcoming problems associated with navigation over polar regions.	2
6.3.10	Describe the construction and operation of a typical heading indicator.	2
63.11	Interpret information displayed on a heading indicator and describe the use of typical controls.	1
6.3.12	Describe how deviation is removed using either mechanical or electrical type correctors.	2
6.3.13	Diagnose faults in a typical RR compass system.	3
6.4	**Attitude Heading Reference System (AHRS)**	
6.4.1	Describe the advantages of an AHRS over a normal remote reading compass system.	2
6.4.2	Describe the sensors used and the operation of the system in providing a stable magnetic heading.	2
6.4.3	List the outputs available and the systems that utilise the outputs from an AHRS system.	1
6.4.4	Describe the importance of a valid TAS signal in relation to the operation of the AHRS.	2
6.4.5	Describe how a compass swing is carried out on an AHRS.	2

7	Inertial Navigation and Inertial Reference Systems	
7.1	**Terminology**	
7.1.1	Define the following and describe their relevance to inertial system: a. Align b. Area azimuth c. Bearing (true, magnetic and relative) d. Co-ordinate system e. Course f. Cross track g. Cross track error h. Crosscouple i. Dead reckoning navigation j. Drift k. Drift angle l. Elevation m. Great circle n. Grid o. Ground speed p. Gyrocompass q. Heading (true and magnetic) r. Latitude s. Local vertical t. Longitude u. Orthogonal v. Pendulum w. Present position x. Polar co-ordinates y. Rhumb line z. Track aa. Track angle error bb. Waypoint	2
7.2	**Inertial navigation System (INS) Fundamentals and System Components**	
7.2.1	Define Newton's second law and describe how it relates to inertial navigation.	2
7.2.2	Define the following terms: a. Inertia b. Velocity c. Acceleration d. Displacement	2
7.2.3	Describe how velocity and displacement vary with time.	2
7.2.4	Describe the basic construction, operation and function of mechanical gyroscopes and accelerometers used in a typical INS system.	2
7.2.5	Describe the basic construction and layout of a typical platform.	2
7.2.6	Describe the following errors and how they are eliminated from an INS: a. Gimbal lock b. Random drift c. Crosscouple	2

7.3	**Reference System Stabilisation**	
7.3.1	Describe the operation of the following items in maintaining the stable element level: a. Gyroscopes b. Accelerometers c. Gimbal system. d. Azimuth resolver	2
7.3.2	Describe the method by which aircraft heading and attitude is measured.	2
7.3.3	Describe the basic operation of a wander azimuth inertial system.	2
7.3.4	Describe its advantage over a typical north pointing system.	2
7.4	**Accelerometer Corrections**	
7.4.1	Describe centripetal and coriolis errors.	2
7.4.2	Describe how the above errors affect the output from the accelerometers	2
7.4.3	Describe the factors that affect the above errors.	2
7.4.4	Describe how these errors are overcome in a typical system.	2
7.5	**Operational Platforms**	
7.5.1	Describe earth rate and transport rate and how they affect the orientation of the stable element.	2
7.5.2	State the factors which affect them and describe how they are compensated for in the overall operation of the system.	2
7.5.3	Describe the Schuler pendulum and list the factors that affect it.	2
7.5.4	Describe how the Schuler pendulum affects the operation of an INS system and how the platform is Schuler tuned.	2
7.6	**Platform Alignment**	
7.6.1	Describe the operation of an inertial navigation system during the following modes of self-alignment: a. Rough alignment (caging) b. Fine alignment (levelling) c. Gyrocompassing	2
7.6.2	Describe the difference in the alignment between a typical north pointing system and an azimuth wander system.	2
7.7	**System Integration**	
7.7.1	Identify and state the purposes of the components in a typical INS system.	2
7.7.2	List the inputs to and output available from an INS.	1
7.7.3	Describe the procedure of aligning an INS before flight and indications provided during flight.	2

7.8	**Strapdown Systems**	
7.8.1	Describe the construction and operation of a strapdown inertial navigation system.	2
7.8.2	State the differences between strapdown and conventional gimbaled systems.	1
7.8.3	Describe the differences between INS and inertial reference system (IRS)	2
7.9	**Laser Gyros**	
7.9.1	Describe the construction, operation, and readout technique of a typical laser gyro.	2
7.9.2	Describe the limitations and methods of improving the limitations of laser gyros.	2
7.10	**Inertial Reference Systems**	
7.10.1	List the components which comprise a typical inertial reference system.	1
7.10.2	Describe the operation, function and construction of a typical IRS.	2
7.10.3	Describe the method by which information is passed between system components.	2
7.10.4	Describe how redundancy is achieved in an IRS. (Various data buses)	2
7.10.5	Describe the method by which true heading is converted in to magnetic heading.	2
7.10.6	List the inputs required for system operation and information available from the system.	1
7.10.7	In relation to maintenance BITE and failure monitoring, describe the limitations, indications provided, conditions and procedures for obtaining maintenance data.	2
7.10.8	Describe the operation and identify the indications provided by the system during the various modes of operation.	2

8	Oxygen Systems	
8.1	**General**	
8.1.1	Describe the gas composition of the atmosphere.	2
8.1.2	Define hypoxia, anoxia, hyperventilation and carbon monoxide poisoning and the symptoms applying to them.	2
8.1.3	Describe the properties and characteristics of oxygen.	2
8.2	**Forms of Oxygen**	
8.2.1	Describe the following forms of forms of oxygen as used in aviation: a. Gaseous b. Liquid c. Chemical or solid state d. Mechanically separated	1
8.2.2	Describe the differences between aviation breathing oxygen and oxygen available for commercial or medical use.	2
8.3	**Oxygen System and Associated Components**	
8.3.1	Describe the purpose, construction and operation of the following oxygen system components: a. High and low pressure cylinders b. Manual continuous flow regulators c. Automatic continuous flow regulators d. Demand regulators e. Diluter demand regulators f. Pressure demand regulators g. Airflow metering aneroid h. Continuous flow masks, re breather type masks or bags i. Demand type masks j. Filler valves k. Pressure gauges l. Continuous flow couplings m. Flow indicators n. Oxygen plumbing including materials used for rigid pipes and fittings o. Smoke protection equipment p. Passenger service units q. Charging valves r. Quantity and pressure indicators	2

8.4	**Continuous Flow and Pressure Demand Systems**	
8.4.1	Describe the construction, layout and purpose of continuous flow and pressure demand oxygen systems.	2
8.4.2	Describe how flow testing is carried out for each system.	2
8.5	**Liquid Oxygen (LOX) Systems**	
8.5.1	Describe the construction and layout of a liquid oxygen system with particular regard to the following components: a. Relief valves b. LOX container c. Check valves d. Filter valves e. Build up valve f. Coils g. Pressure closing valves	1
8.6	**Chemical Oxygen Systems**	
8.6.1	Describe the construction, layout and operation of a typical chemical oxygen system with regard to the following criteria: a. Candle construction b. Performance characteristics c. Precautions	2
8.7	**Portable Oxygen Equipment**	
8.7.1	Describe the construction, operation, performance limitations and uses of portable oxygen equipment.	2
8.7.2	Describe how the contents of portable oxygen cylinders are checked.	2
8.8	**System Advantages**	
8.8.1	Describe the features, advantages and disadvantages of solid state versus high-pressure gaseous oxygen systems.	2
8.8.2	Describe the type of system most commonly used for crew oxygen.	2

8.9	**Oxygen System Servicing and Precautions**	
8.9.1	Describe oxygen system servicing with particular regard to the following factors: a. Leak testing of gaseous oxygen systems and the materials that may be used b. Used graphs or other technical date to establish leak rates against system gauge pressure c. Cleaning system components d. Draining of the system e. Purging the system and the purging gasses normally used f. Filling the system g. Pressure/ temperature correction h. Filling a LOX system i. Inspecting masks and hoses j. Replacing tubing, valves and fittings k. Clearance between oxygen lines and electrical wiring l. Testing and lifing of cylinders and other components m. Typical system inspection and maintenance procedures n. Maintenance of a typical oxygen dispensing trolley o. Breathing oxygen cylinder identification (colour and lettering) p. Flaring and the types of flare used for rigid oxygen system lines q. Typical charge pressures for the various types of oxygen cylinder r. Colour code identification of oxygen system lines s. Testing of oxygen systems t. Use and maintenance of oxygen test equipment	2
8.9.2	Describe precautions to be taken to prevent oxygen fires and explosions.	2