CIVIL AVIATION AUTHORITY OF FIJI

GUIDANCE MATERIAL

Aircraft Maintenance Engineer Licence – Examination Module 15 – Radio Systems

AMEL-EM15

Published by:

Civil Aviation Authority of Fiji
Private Mail Bag, NAP 0354
Nadi International Airport
Fiji

www.caaf.org.fj

PREFACE

This Guidance Material (GM) is published by the Civil Aviation Authority of Fiji for purposes of promulgating supplementary material to that published in the Authority's Standards Documents.

This GM provides guidance to aircraft maintenance engineering personnel and CAAF staff on the acceptable means of compliance with the syllabus content in respect of written examinations for **Module 15 – Radio Systems.**

This GM explains certain regulatory requirements by providing interpretive and explanatory material.

Chief Executive
Civil Aviation Authority of Fiji

THIS PAGE IS INTENTIONALLY LEFT BLANK

Table of Contents

Eligibility Requirements

ANR 53(2) requires an applicant for an AMEL to have passed written examinations, that areacceptable to the Authority, relevant to the duties and responsibilities of an aircraft maintenance engineer in the category of licence sought.

The written examinations acceptable to the Authority for Module 15 (Radio Systems) should comply with the syllabus contained in this GM. 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: Module 15

The pass mark for Module 15 (Radio Systems) is 70 %.

An application to sit an examination may be made directly to ASPEQ. Refer to https://caaf.aspeqexams.com/home for examination information.

General Examining Objective

The objective of the examination is to determine that the applicant for an AMEL has adequate knowledge of Module 15 – Radio 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 be:

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

1. understand the theoretical fundamentals of the subject
2. give a general description of the subject using, as appropriate, typical examples
3. use mathematical formulae in conjunction with physical laws describing the subject
4. read and understand sketches, drawings and schematics describing the subject
5. 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.

Where applicable, publication references have been placed below each main topic or sub topic heading in this syllabus.

Publication List

Study Ref	Book Title	Author	ISBN
1	Aircraft Radio Systems	James Powell	0-89100-356-8
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	Max F. Henderson	0-89100-422-X
5	Dictionary of Aeronautical Terms	Dale Crane	1-56027-287-2

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 whichrefer 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 identifiedby 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: Module 15 – Radio Systems

1. Radio Theory		
1.1	**Radio Wave Propagation**	
1.1.1	Identify the bands of the frequency spectrum and be able to describe their use and propagation characteristics.	2
1.1.2	Describe the properties of the ionosphere and troposphere.	2
1.1.3	Describe the following factors relating to radio waves: a. Radio frequency b. Spectrum c. Bands d. Uses e. Propagation characteristics.	2
1.1.4	Describe the following criteria: a. Causes and effects of absorption b. Scatter c. Reflection d. Refraction e. Fading f. Cyclic and irregular variations g. Critical Frequency h. Maximum useable frequency i. Temperature inversion j. Ducting.	2
1.1.5	Describe the relationship between velocity of propagation, frequency and wavelength.	2
1.1.6	Explain the following terms: a. Ground wave b. Sky wave c. Surface wave d. Space wave e. Radiation angle f. Skip distance g. Diffraction h. Field Strength i. Doppler effect.	2
1.1.7	Describe the effect that water and various land surfaces have on radio wave propagation.	2

2. Fundamentals of Antennas		
2.1	**Principles of Antennas**	
2.1.1	Describe operation, construction, and radiation field patterns and typical uses of the following antenna types: a. Dipole (half wave length and folded) b. Marconi c. Long wire d. Yagi e. Parabolic f. Loop.	2
2.1.2	Describe the voltage and current distribution along antennae of various lengths.	3
2.1.3	Describe how the electrical length of an antenna may be altered.	3
2.1.4	Describe ground planes, their characteristics and uses.	2
2.1.5	Describe the following terms relating to antennas: a. Antenna impedance b. Radiation resistance c. Radiation power d. Polarization e. Effective height f. Reciprocity g. Gain h. Directivity i. Bandwidth j. Beamwidth k. Lobes l. Isotropic radiator.	2
2.1.6	Describe the characteristics, advantages, disadvantages and typical aircraft locations of the following antennas: a. Blade b. Notch c. Probe d. Whip e. Wire f. Parabolic g. Flat plate h. Horn.	2
2.1.7	Identify the particular communications system that each of the above antennas would be associated with.	2

3. Radio Circuit Analysis		
3.1	**Radio Circuit Principles**	
3.1.1	Describe the characteristics, and applications of series and parallel resonant circuits.	2

4. Radio Transmission Lines		
4.1	**Theory of Radio Transmission Lines**	
4.1.1	Describe the construction and characteristics of the following types of transmission line: a. Parallel wire b. Co-axial cable c. Wave guide d. Twisted pair.	2
4.1.2	Define the following terms: a. Characteristic impedance b. Reflected power c. Forward power d. Standing wave ratio e. Balanced line f. Unbalanced line g. Velocity factor.	2
4.1.3	Explain the effect on a transmission line when it is terminated in an: a. impedance equal to its characteristic impedance. b. open circuit. c. short circuit.	3
4.1.4	Explain how a transmission line can be used as a matching device or filter.	3
4.1.5	Explain how transmission lines can be used to feed various types of antenna.	3

5. Radio Receivers		
5.1	**Principles of Receivers**	
5.1.1	Describe the characteristics of following types of radio signal: a. Amplitude modulation b. Frequency modulation.	2
5.1.2	Explain the sources of, and the steps taken to reduce both random and non-random noise.	3

5.1.3	Describe the following terms: a. Sensitivity b. Selectivity c. Stage gain d. Bandwidth e. Resonance f. Image rejection g. Adjacent channel rejection h. Noise factor i. Distortion.	2
5.1.4	Explain the operation, characteristics and construction of: a. Headphones b. Speakers c. Microphones.	2
5.1.5	Identify and be able to explain, both in the time and frequency domain, the following signals and methods used to demodulate them: a. Amplitude modulated (AM) b. Frequency modulated (FM) c. Single sideband d. Continuous wave.	2
5.1.6	Describe the function of the following: a. Automatic frequency control b. Clarifiers c. Limiters d. Noise limiters e. Squelch control.	2

6. Radio Transmitters		
6.1	**Principles of Transmitters**	
6.1.1	Identify, describe and state the characteristics of the stages that comprise amplitude and frequency modulated transmitters.	2
6.1.2	Describe the various types of modulator used to generate the following types of signal: a. Amplitude modulated b. Frequency modulated c. Single sideband (SSB).	2

6.1.3	Define the following terms: a. Bandwidth b. Modulation index c. Clipping d. Harmonics e. High level modulation f. Low level modulation g. Frequency stability h. Output power i. Parasitic oscillation j. Neutralisation.	2
6.1.4	Explain why a receiver is muted during transmission.	2
6.1.5	Describe the classes of operation of transmitter power output stages.	2
6.1.6	Describe the operation and limitations of regulated power supplies and switched mode powersupplies, (DC to DC converter).	2

7. Communication Systems – General		
7.1	**Basic Communication Theory**	
7.1.1	Identify the frequency bands and channel spacing allocated to the following airbornecommunications systems: a. High frequency (HF) b. Very high frequency (VHF) c. Ultra-high frequency UHF d. Satellite (SATCOM).	2
7.1.2	Detail the following factors for the above airborne communications systems: a. Power output b. Sensitivity c. Stability.	3
7.1.3	In relation to HF, VHF and UHF airborne communications systems: a. Describe the methods of propagation and ranges expected both day and night. b. Using given data calculate approximate ranges. (line of sight).	2
7.1.4	Describe the purpose and principles of operation of a selective calling (Selcal) system for HF andVHF communications.	2

8. High Frequency (HF) Communication Systems		
8.1	**Theory of High Frequency (HF) Communication Systems**	
8.1.1	Describe the principles of operation of a typical HF transceiver with particular regard to thefollowing factors: a. Components comprising an airborne HF system b. Type of modulation c. Ground wave attenuation d. Selective fading e. ARINC 559A f. Typical aircraft locations of HF hardware g. Audio system interface h. Power supplies i. Typical data display on front cover j. Antenna coupling via an ATU k. Closed loop control l. ATU Pressurisation m. Antenna lightning protection methods n. Precipitation dissipation methods o. Trailing wire antenna p. Fixed antenna couplings for light aircraft systems q. Antenna selections for low and high-speed aircraft r. Composition, construction and corrosion protection of wire antennae s. Moisture protection in antennae including water drains t. Antenna weak links and shear points u. Antenna tethering points and tethering hardware v. Notch antenna w. Notch inductance x. Signal injection y. Airframe radiation principles z. Probe antenna principlesaa. Probe antenna location aa. Functions on an interlock unit for dual installations bb. Controllers cc. Mode selection dd. Data links ee. Frequency selectors ff. Transmitter keying gg. Squelch control hh. Audio volume control ii. Functions of a clarifier.	2
8.1.2	Describe the purpose of an antenna tuning unit.	2
8.1.3	Describe to block diagram level the basic theory of operation of an antenna tuning unit (ATU).	2
8.1.4	Describe the differences between and preset and automatic antenna tuning units and state theadvantages and disadvantages of each.	2
8.1.5	Describe to block diagram level the components in typical HF AM SSB transceiver.	2

8.1.6	Describe the principles of operation of a typical HF transceiver with particular emphasis on thefollowing: a. Amplitude modulated transmission b. Single side band transmission c. Amplitude modulated reception d. Single sideband reception e. Antenna tuning unit.	2
8.2	**Maintenance and Testing of HF Communications Systems**	
8.2.1	Describe typical maintenance activities performed on an HF radio system including the following: a. Antenna inspection relating to tensioning units and mounting points b. Spark gaps c. Functional testing and communication with other stations d. Safety precautions e. Inadvertent transmission following a frequency change f. Hardware security and bonding g. VSWR testing.	2

9. VHF and UHF Communication Systems		
9.1	**Theory of Very High Frequency (VHF) Communication Systems**	
9.1.1	Describe the following factors relating to a VHF transceiver: a. Meaning of single or double conversion super heterodyne b. Components comprising a single airborne VHF system c. Transmitter modulation d. Number of channels available e. Single channel simplex (s.c.s) and double channel simplex (d.c.s) f. Multiple VHF systems in large aircraft g. ARINC 566 with satcom h. Typical aircraft locations of VHF hardware i. Audio system interface j. Power supplies k. Typical data display on front cover l. VHF antenna types and position on the aircraft m. Antenna polarisation n. In-use and standby frequencies o. Automatic test equipment facility.	2
9.1.2	Describe to block diagram level the principles of operation of a typical VHF transceiver.	2

9.1.3	Describe the VHF system controls, their operation and limitations including the following: a. Frequency control b. Volume control c. Squelch control d. Mode selector control e. On-off switch f. Receiver selectivity switch.	2
9.1.4	Describe to block diagram level the principles of operation of an ARINC Communications Addressingand Reporting System (ACARS).	2
9.1.5	Describe the following characteristics, functions and terms relating to an ARINC 566 airborne VHFcommunications and satcom: a. Channel spacing b. Receiver muting c. Channel selection d. Channelling time e. Receiver sensitivity f. Selectivity g. Cross modulation h. Undesired responses i. Gain j. Frequency response k. Harmonic distortion l. AGC m. Transmitter stability n. Power output o. Sidetone p. Microphone input q. Antenna vertically polarised and omnidirectional r. Antenna impedance.	2
9.2	**Maintenance and Testing of VHF Communications Systems**	
9.2.1	Describe typical maintenance activities performed on an airborne VHF communications systemincluding the following: a. Antenna inspection including mounting points and ground planes as appropriate. b. Functional testing and communication with other stations c. Precautions especially during refuelling d. Use of an emergency frequency e. Hardware security and bonding f. VSWR testing g. A typical ramp test.	2
9.2.2	Describe the types and sources of radio interference associated with VHF systems and describemethods of eliminating interference.	2

9.3	**Ultra-High Frequency (UHF) Communications**	
9.3.1	Describe to block diagram level, the principle of operation of a typical UHF transceiver.	2
9.4	**Satellite Communications**	
9.4.1	Describe to block diagram level, the principle of operation of a typical SATCOM transceiver.	2

10. Emergency Locator Transmitters (ELT)		
10.1	**Theory and Operation of Emergency Locator Transmitters**	
10.1.1	Describe the procedure for testing an ELT.	2
10.1.2	Describe battery life limitations as they pertain to an activated or unactivated ELT.	2
10.1.3	State the safety precautions to be observed when working with ELTs with particular regard tospurious or unintentional transmissions.	1

11. Audio Systems		
11.1	**Audio Integration and Interphone**	
11.1.1	Describe the characteristics of sound including the upper and lower hearing limits.	2
11.1.2	Describe the use of matching transformers in audio systems.	2
11.1.3	From given data, calculate the impedance and turns ratio of matching transformers.	2
11.1.4	Describe the uses and characteristics of the following: a. Isolation amplifiers b. Attenuators c. Distribution networks d. Side tone e. Muting f. Insertion loss.	2
11.1.5	Describe the purpose of the following audio integration and interphone systems: a. Public address (PA) b. Flight interphone c. Service interphone d. Cabin interphone.	2
11.1.6	Describe the function of operating controls of integration and interphone systems.	2
11.1.7	Describe to block diagram level, the theory of operation of audio integration and interphonesystems.	2

11.1.8	With respect to audio integration and interphone systems, describe the practices and proceduresfor the following: a. Fault diagnosis and trouble shooting b. Installation c. Maintenance and testing.	2
11.1.9	Identify the interface protocols for the following passenger entertainment systems: a. Video b. Audio c. Interactive.	2
11.1.10	Describe typical performance levels and specifications expected from an aircraft audio system.	2
11.1.11	Describe how noise and other undesirable influences are eliminated from an aircraft audio system.	2
11.1.12	Describe how audio systems interface with other aircraft systems.	2
11.1.13	Describe how the life and condition of battery power supplies associated with audio systems ismonitored and controlled.	2
11.2 11.2.1	**Microphones** In relation to microphones describe the following: a. Output levels b. Frequency response c. Directional properties.	2

12. Cockpit Voice Recorder (CVR) Systems		
12.1	**Theory of Cockpit Voice Recorder (CVR) Systems**	
12.1.1	Describe the purpose and requirements of a cockpit voice recorder system.	2
12.1.2	Describe the performance levels expected and the specifications of a typical CVR system.	2
12.1.3	Describe to block diagram level, the theory of operation of a cockpit voice recorder.	2
12.1.4	Describe typical locations for cockpit microphones.	2
12.1.5	Describe the concept of “hot” and “area” microphones.	2
12.1.6	Describe the following terms relating to cockpit voice recorders: a. Cross talk b. Wow and flutter c. Record head d. Erase head e. Bias oscillator f. Bulk erase g. Track h. Frequency response i. Monitor head.	2

12.1.7	Describe the installation of a CVR with particular regard to the following: a. Favourable location b. Power supplies c. Interface with the audio system.	2
12.1.8	Describe audio and visual tests for a typical CVR system.	2
12.1.9	Describe typical procedures for downloading CVR recordings.	2
12.1.10	Describe the following in regard to an underwater locator beacon: a. Purpose b. Function c. Testing d. Battery type e. Battery life.	2
12.1.11	Describe how a CVR is protected against the following: a. Shock b. Fire c. Immersion in fluids d. Erasure of recordings.	2
12.1.12	Describe typical procedures for CVRs in respect of the following: a. Maintenance b. Fault diagnosis c. Troubleshooting.	2

13. Automatic Direction Finder (ADF) Systems		
13.1	**Principles of ADF Operation**	
13.1.1	Describe the principles of aircraft navigation using an ADF system.	2
13.1.2	Describe the following terms: a. Relative bearing b. Magnetic bearing c. Drift angle d. Homing e. Position fixing f. Aural bearing.	2
13.1.3	Describe the difference between a relative bearing indicator (RBI) and a radio magnetic indicator(RMI).	2
13.1.4	Describe the sources, effects and remedies of the following interference and system errors: a. Coastal refraction b. Mountain effect c. Night effect d. Static interference e. Station interference f. Vertical effect.	2

13.1.5	Describe the field patterns for, or radiated by, the following: a. Non-directional radio beacon (NDB) b. ADF ground station c. Loop antenna d. Sense antenna e. Combined loop/sense antenna.	2
13.1.6	Describe the following: a. Composite field pattern of a loop and sense antenna (cardioid) b. Phase relationship between loop and sense antenna output signals c. Antenna feeder lengths d. Sense antenna quality factor e. Sense antenna critical capacitance.	2
13.1.7	Describe the construction of the following: a. Sense antenna b. Loop antenna.	2
13.1.8	Describe the phase relationship between sense and loop antenna output signals.	2
13.1.9	Describe the following characteristics of a typical ADF system: a. Accuracy b. ADF hunting c. Frequency range d. Sensitivity.	2
13.1.10	Describe the functioning of the following operating controls of an ADF receiver: a. ADF b. Antenna c. Beat frequency oscillator d. Frequency select e. Gain f. Loop.	2
13.1.11	Describe the principle of operation, to block diagram level, of a typical ADF receiver including thefollowing: a. ADF to RMI adaptors b. Loop antennas a goniometer c. Beat frequency oscillators d. Balanced modulator e. Frequency synthesis f. Channel selection.	2
13.2	**ADF Installation and Maintenance**	
13.2.1	Describe the practices and procedures used in the installation of ADF systems including thefollowing: a. Location and mounting b. Power supplies c. Interface with audio system d. Interface with navigation system.	2

13.2.2	Describe the relevance of the critical lengths of antenna cables.	2
13.2.3	Describe the procedures used to diagnose and rectify defects in ADF systems.	2
13.2.4	Describe the practices and procedures used to test ADF systems after installation, replacement or adjustment of units.	2

14. Very High Frequency Omnidirectional Range (VOR) Systems		
14.1	**Principles of VOR Operation**	
14.1.1	Describe the principles of aircraft navigation using VOR systems with particular emphasis on the following: a. Intercepting an inbound track b. Intercepting an outbound track c. Tracking/homing directly to a VOR station.	2
14.1.2	Define the following terms and know how they relate to the operation of a VOR system: a. Radial b. Heading c. Automatic d. Automatic VOR e. Manual VOR f. Selected course g. Track h. Cone confusion.	2
14.1.3	Describe the field patterns and signals radiated by ground VOR stations.	2
14.1.4	Describe the following characteristics of a typical VOR receiver: a. Frequency range b. Channel spacing c. Signal polarization d. Variable phase circuitry e. Resolver f. Reference phase amplifier g. VOR warning and TO/FROM circuitry h. Omni bearing selection i. Omni accuracy j. Omni sensitivity.	2
14.1.5	Describe the field patterns and signals radiated by ground VOR stations.	2
14.1.6	With respect to VOR, describe the presentation of bearing information on a radio magnetic indicator (RMI) and omni-bearing selector. (OBS)	2

14.1.7	Describe the following outputs of a typical VOR system and their interface with other systems: a. Distance measuring equipment (DME channelling b. Audio output c. Autopilot output d. Omni bearing information to RMI/OBS e. TO/FROM f. Warning g. Deviation from selected radial h. Audio to audio integration (AIS).	2
14.1.8	Describe the purpose of the operating controls of a typical VOR receiver.	2
14.1.9	Describe the errors that can affect a VOR system including the following: a. Course error b. Reciprocal error c. VOR site error.	2
14.1.10	Describe to block diagram level the theory of operation of a typical VOR receiver.	2
14.1.11	Describe the purpose of compensating load resistors in place of indicators.	2
14.1.12	Describe the following criteria in regard to VOR antenna: a. Types b. Dual systems run from a single antenna c. Receiver duplexer d. Diplexers e. Critical cable lengths.	2
14.2	**VOR Installation and Maintenance**	
14.2.1	Describe the practices and procedures used in the installation of VOR systems, including thefollowing: a. Location b. Mounting c. Antenna location.	2
14.2.2	Describe the practices and procedures used to diagnose and rectify faults in VOR systems.	2
14.2.3	Describe the practices and procedures used to test VOR systems after installation, replacement oradjustment of units. Includes the proper use of a bearing simulation test set.	2

15. Instrument Landing Systems (ILS)		
15.1	**Principles of ILS Operation**	
15.1.1	Describe a typical ILS system comprising a localiser, glideslope and marker.	2

15.1.2	Describe the operation of an ILS, including ground station position, with respect to: a. Runway. b. Signal format. c. Range. d. Information displayed to the pilot.	2
15.1.3	Describe the location of, and the field patterns radiated by, the following ground stationtransmitters: a. Glideslope b. Localiser c. Marker.	2
15.1.4	Describe the characteristics of a typical localiser system with regard to the following: a. Channel spacing b. Frequency range c. Modulation d. Pairing of localiser and glideslope channels e. Signal polarisation f. Joint VOR/LOC antenna.	2
15.1.5	Describe the purpose and functioning of the operating controls of a typical localiser receiver.	2
15.1.6	Describe the characteristics of a typical glideslope system in regards to the following: a. Channel spacing b. Frequency range c. Modulation d. Signal polarisation e. Antenna.	2
15.1.7	Describe the characteristics of a typical marker beacon receiver system with particular regard to thefollowing: a. Operating frequency b. Modulation c. Antenna.	2
15.1.8	Describe the purpose of operating controls and indicators on a typical marker beacon receiver.	2
15.1.9	Describe the presentation of localiser and glideslope information on the following: a. Course deviation indicators b. Horizontal situation indicators c. Glideslope indicators d. Attitude direction indicators e. Marker lights f. Tones.	2

15.1.10	Describe the following outputs of a typical ILS system: a. Audio b. Auto pilot c. Localiser/glideslope d. Warning.	2
15.1.11	Describe localiser back course switching, and when installed, the required glideslope precautions.	2
15.1.12	Describe the use of load resistors to compensate for removal of one or more indicators in a multi-indicator ILS installation.	2
15.1.13	Describe the meaning of the term difference in depth modulation (DDM).	2
15.1.14	Describe, to block diagram level, the principle of operation of a typical localiser receiver withparticular regard to the following: a. Receiver element b. Filters c. Oscillators d. Flag circuit e. Meter circuit f. Power supplies.	2
15.1.15	Describe, to block diagram level, the principle of operation of a typical glideslope receiver withparticular regard to the following: a. Receiver element b. Filters c. Oscillators d. Flag circuit e. Meter circuit f. Power supplies.	2
15.1.16	Describe, to block diagram level, the principle of operation of a typical marker beacon receiver withparticular regard to the following: a. Receiver element b. Filters c. Lamp circuits d. Sensitivity circuitry e. Power supplies.	2
15.2	**Localiser, Glideslope and Marker Beacon Installation and Maintenance**	
15.2.1	Describe the practices and procedures used in the installation of the following receiver systems: a. Localiser b. Glideslope c. Marker beacon.	2
15.2.2	Describe the practices and procedures used to diagnose and rectify defects in ILS systems.	2

15.2.3	Describe a typical system installation with regard to the following: a. Location of components b. Mounting of components c. Antenna locations.	2
15.2.4	Describe the practices and procedures used to test ILS systems after installation, replacement or adjustment of units with particular regard to the use of an appropriate ILS/MKR signal simulatortest set.	2
15.2.5	Describe the interface of the ILS/MKR system with audio and navigational systems.	2

16. Satellite Navigation Systems (GNS) (GPS) (GLONASS)		
16.1	**Principles of Satellite Navigation.**	
16.1.1	Describe the following factors upon which GNS operation depends: a. Atmospheric errors b. Constellation c. Ephemeris errors d. Geometry error (PDOP) e. Principle of satellite ranging f. Pseudo-random code g. Timing requirements.	2
16.1.2	Describe the principles and characteristics of differential GNS, including: a. Wide area b. Local area c. Pseudo-lite.	2
16.1.3	Describe the necessity for Differential GNS.	2
16.1.4	Describe the characteristics of typical GNS receivers, either stand-alone (Panel mounted generalaviation type) or fully integrated systems, including: a. Inputs b. Outputs	2
16.1.5	Describe the purpose of receiver autonomous integrity monitoring (RAIM).	2
16.1.6	Describe the process by which RAIM operates.	2
16.1.7	Describe the construction, use and characteristics of GNS antennas and transmission lines.	2
16.1.8	Describe the functioning of the operating controls and indications of a typical GNS receiver.	2
16.1.9	Describe to block diagram level, the principle of operation of a typical GNS including the following: a. Receiver inputs b. Outputs c. Interfaces d. Integration aspects.	2

16.1.10	Describe the recommended practices and procedures used in the installation of GNS.	2
16.1.11	Describe the recommended practices and procedures used to diagnose and rectify defects in GNS, including any subsequent testing and monitoring of the system.	2
16.1.12	Describe the operation of a GPS landing system to block diagram level.	2
16.1.13	In a GPS landing system list the components, inputs and outputs of the system and the interface and interrogation between it and other avionic systems.	2

17. Radar Systems Theory		
17.1	**Radar Theory**	
17.1.1	Describe the following factors on which radar operation depends: a. Channelling of radio frequency (RF) energy into beams b. Scatter or reflection of RF energy c. Speed of propagation of an RF wave.	2
17.1.2	Describe the following terms: a. Beamwidth b. Frequency of transmission c. Pulse repetition frequency d. Pulse width e. Radar mile f. Receiver signal strength g. Automatic frequency control h. Sensitivity time control.	2
17.1.3	Describe the principles of operation and uses of the following: a. Antenna stabilisation b. Antenna tilt c. Gyro stabilisation.	2
17.1.4	Describe the construction, uses and principles of operation of the following: a. Choke joints b. Flexible wave guides c. Non resonant lines d. Resonant cavities e. Resonant lines f. Rigid waveguides g. Rotary joints h. T/R switches.	2

17.1.5	Describe the construction, uses and principles of operation of the following: a. Circulators b. Isolators c. Gunn diodes d. Impatt diodes e. Klystrons f. Magnetrons g. Travelling wave tubes h. Strip lines i. Micro-strip devices.	2
17.1.6	Describe the construction and principles of operation of flat plate and parabolic antenna including their radiated field patterns.	2

18. Weather Radar Systems		
18.1	**Weather Radar**	
18.1.1	Describe the functioning of the operating controls and indications of a typical weather radar system.	2
18.1.2	Describe, to block diagram level, the principle of operation of a typical weather radar system with particular regard to the following: a. Weather radar transmitter b. Weather radar receiver c. Weather radar indicator.	2
18.1.3	Describe the following: a. CRT displays b. Information presentation c. Ranges d. Weather e. Mapping.	2
18.1.4	Describe the interface of weather radar with other aircraft systems.	2
18.1.5	Describe the precautions to be observed when operating radar systems.	2
18.1.6	Describe the operation of Stormscope weather detection system with particular regard to the following: a. Range b. Area c. Coverage d. Antenna e. Limitations.	2
18.1.7	Describe the practices and procedures used in the installation of weather radar systems.	2
18.1.8	Describe the practices and procedures used to diagnose and rectify defects in weather radar systems.	2

18.1.9	Describe the practices and procedures used to test weather radar systems after installation, replacement or adjustment of units.	2

19. Distance Measuring Equipment (DME)		
19.1	**Theory of DME Systems**	
19.1.1	Describe the theory of DME systems, including ground station responses.	2
19.1.2	Describe the characteristics of interrogation and reply pulse trains.	2
19.1.3	Describe the location and function of ground beacons including co-located VOR/DME (or VORTAC, VOR and TACAN beacons)	2
19.1.4	Describe the following terms: a. Jitter b. Automatic standby c. Squitter d. Search e. Track f. Memory g. Percentage reply echo protection h. Suppression.	2
19.1.5	Describe the characteristics of a DME system including the following: a. Transmitted frequency b. Received frequency c. Transmitter power d. Useful range e. Number of channels f. Outputs.	2
19.1.6	Describe the principles of operation of a typical DME receiver with particular regard to theincluding: a. Interrogation function b. Reply and decoding circuitry c. Indicator d. Power supplies e. Antenna.	2
19.1.7	Describe how interference with and from other avionics is minimised.	2
19.1.8	Describe the installation of a typical DME system with particular regard to the following: a. Location b. Mounting c. Antenna position.	2
19.1.9	Describe the testing of DME systems and the operation of an appropriate DME test set.	2

20. Air Traffic Control Transponder Systems		
20.1	**Transponder Principles**	
20.1.1	In relation to Air Traffic Control, describe the difference between primary and secondarysurveillance radar (SSR).	2
20.1.2	Describe the radiated field pattern of secondary surveillance radar.	2
20.1.3	Describe the presentation of data on an ATC radar display.	2
20.1.4	Describe the principle of operation of an ATC transponder system with particular regard to thefollowing: a. Transmitter b. Receiver c. Code d. Interrogation e. Mode f. Reply g. Side lobe suppression.	2
20.1.5	Describe the following characteristics of a typical ATC transponder system: a. Antenna polarisation b. Receive frequency c. Suppression d. Transmit frequency e. Transmitter power output f. System range.	2
20.1.6	Describe the characteristics of the following secondary surveillance radar modes of operation: a. Mode A b. Mode C c. Mode S.	2
20.1.7	Describe the functions of modes “A” and “C” and the attitude reporting function.	2
20.1.8	Describe the Mode “S” interface with Traffic Alert and Collision Avoidance Systems (TCAS).	2
20.1.9	Describe the characteristics of ground transmitted interrogations and transponder reply pulsetrains.	2
20.1.10	Describe the functioning of the operating controls and indications of a typical ATC transpondersystem.	2
20.1.11	Describe the interface of a transponder with other aircraft systems.	2
20.1.12	Describe to block diagram level, the principle of operation of a typical ATC transponder receiverdecoder.	2
20.1.13	Describe to block diagram level, the principle of operation of a typical ATC transponder transmitter.	2

20.1.14	Describe the practices and procedures used in the installation of a typical ATC transponder system	2
20.1.15	Describe the practices and procedures used to diagnose and rectify defects in ATC transpondersystems.	2
20.1.16	Describe the practices and procedures used to test ATC transponder systems after installation,replacement or adjustment of units, including the correct use of test equipment.	2

21. Area Navigation (RNAV)		
21.1	**RNAV Principles of Operation**	
21.1.1	Describe the principles of area navigation using VOR and DME systems.	2
21.1.2	Describe waypoint offset computation.	2
21.1.3	Describe the control of an RNAV system including the following: a. Data entry b. Output information presentation. c. Output information interpretation.	2
21.1.4	Describe the installation of a typical RNAV system and its interface with DME and VOR systems aswell as other systems in the aircraft.	2
21.1.5	Describe switching and annunciation of mode of operation of a typical RNAV system.	2
21.1.6	Describe the testing of an RNAV system by using appropriate VOR and DME test sets.	2

22. Radio Altimeter Systems		
22.1	**Radio Altimeter Principles**	
22.1.1	Describe the principles of operation of the following radio altimeter systems: a. Frequency modulated carrier wave (FMCW) b. Constant difference frequency modulated carrier wave (CDFMCW) c. Pulsed	2
22.1.2	Describe the characteristics of a typical radio altimeter system with particular regard to thefollowing: a. Accuracy b. Frequency of operation c. Maximum and minimum height d. Modulation frequency e. Output power f. Outputs.	2

22.1.3	With respect to conventional FMCW radio altimeter systems, describe the following: a. Frequency deviation b. Frequency modulation c. How radio height is measured d. Modulation index e. System errors.	2
22.1.4	Describe the construction, uses and characteristics of Radio Altimeter antennas including microwave and transmission line feeds.	2
22.1.5	Describe the functioning of the operating controls and indications of a typical Radio Altimeter system.	2
22.1.6	Describe to block diagram level, the principle of operation the following Radio Altimeter systems: a. Transmitter b. Receiver c. Indicator.	2
22.1.7	Describe the practices and procedures used in the installation of Radio Altimeter systems.	2
22.1.8	Describe the practices and procedures used to diagnose and rectify defects in Radio Altimeter systems.	2
22.1.9	Describe the practices and procedures used to test Radio Altimeter systems after installation, replacement or adjustment of units.	2
22.1.10	Describe the interface of Radio Altimeter with other aircraft systems.	2

23. Aircraft Collision Avoidance Systems (ACAS) (TCAS)		
23.1	**Principles of Operation**	
23.1.1	Describe the principles of operation of a typical ACAS system.	2
23.1.2	Describe the differences between Traffic Alert and Collision Avoidance (TCAS)-1 and TCAS-2.	2
23.1.3	Describe the difference between a Resolution Advisory (RA) indication and a traffic advisory (TA).	2
23.1.4	Describe the range, altitude and resolution of the operating area including warning indications, both visual and aural, of potential and immediate threats.	2
23.1.5	Describe the location of the ACAS/Mode “S” antennas and the reason for their placement.	2
23.1.6	Describe the operation of an ACAS system and be able to draw a schematic of a typical system.	2
23.1.7	Describe the interface of ACAS with other aircraft systems.	2

23.1.8	Describe the recommended practices and procedures used to diagnose and rectify defects in ACAS.	2
23.1.9	Describe the testing of ACAS including the operation and calibration of any special test equipment.	2

24. Arinc Communication and Reporting System (ACARS)		
24.1	**Principles of ACARS operation**	
24.1.1	Describe the principle, operation and function of ACARS.	2
24.1.2	Describe the information/data processes by an ACARS system with particular regard to parametersand limitations.	2
24.1.3	Describe the function and operation of ACARS ground stations.	2
24.1.4	Describe a typical ACARS installation, including the interface with other aircraft systems.	2
24.1.5	Describe the testing of ACARS including the operation and calibration of special test equipment.	2

25. Installation and Maintenance of Radio and Radar Systems		
25.1	**Installation**	
25.1.1	With regard to airborne communication systems, describe the practices and procedures used in theinstallation of the following devices: a. Antenna tuning units, preset and automatic b. Antennas c. Transceivers d. Interwiring between units e. Controllers f. Microphones, speakers and headsets.	2
25.2	**Maintenance**	
25.2.1	Describe the procedures used to diagnose and rectify defects in airborne communications systems	2
25.2.2	Describe the practices and procedures used to tune antenna tuning units.	2
25.2.3	Describe the practices and procedures used to test airborne communications systems afterinstallation, replacement and adjustment of units.	2
25.2.4	With regard to airborne communications systems, describe the types and sources of interferenceand the methods used to eliminate it.	2

25.3	**Measuring Instruments**	
25.3.1	Describe the operation, use testing and calibration of the following equipment: a. AF and RF signal generators b. Analogue and digital multimeters c. Audio frequency (AF) and radio frequency (RF) output power meters d. Dummy loads e. Frequency meters and counters f. Oscilloscopes g. Spectrum analysers h. Voltage standing wave ratio (VSWR) meter i. Time domain reflectometers (TDR).	2