CIVIL AVIATION AUTHORITY OF FIJI

GUIDANCE MATERIAL

Aircraft Maintenance Engineer Licence – Examination Module 13 – Electrical Systems

AMEL-EM13

Published by:

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

www.caaf.org.fj

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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 13 – Electrical Systems.**

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

Chief Executive
Civil Aviation Authority of Fiji

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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 13 (Electrical 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 13

The pass mark for Module 13 (Electrical 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 13 – Electrical 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 Electrical Systems (3rd Edition)	EHJ Pallett	0-582-98819-5
2	Electrical Systems for A & P	Jeppesen	0-89100-412-2
3	A & P Technician Airframe Textbook	Jeppesen	0-88487-331-5
4	Transport Category Aircraft Systems	Jeppesen	0-88487-232-7
5	Aviation Maintenance Technician Series, Airframe - Volume 2	Dale Crane	1-56027-340-2
6	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 13 – Electrical Systems

1. Electromechanical Systems		
1.1	**Pressurisation Systems**	
1.1.1	Define the following terms and describe their application to aircraft pressurisation: a. Cabin altitude b. Controlled leaks c. Differential control mode d. Differential pressure e. Isobaric control mode f. Maximum differential g. Pressure altitude h. Rate control i. Uncontrolled leaks.	2
1.1.2	Identify from diagrams or schematic drawings the following pressurisation components and describe their principles of operation. a. Cabin altimeters b. Cabin differential pressure indicator c. Cabin rate of climb indicators d. Jet pumps e. Negative pressure relief valves f. Outflow valves g. Pneumatic relays h. Pressure controllers (automatic and manual) i. Safety (positive pressure relief) valves j. Safety switches.	2
1.1.3	Describe a typical system layout including the pneumatic or electrical interconnection of components.	2
1.1.4	Describe the operation and indicate component function in given system operation modes, including the electrical interface and warning/indication systems.	2
1.1.5	Diagnose faults in aircraft pressurisation systems, including the electrical and instrument interface, and indicate how these can be rectified.	3

1.2	**Air Conditioning–Vapour Cycle System**	
1.2.1	Define the following terms: a. Adiabatic b. Conduction c. Convection d. Humidity e. Latent heat f. Latent heat of vaporization g. Radiation h. Relative humidity i. Sensible heat j. Superheat.	2
1.2.2	Solve problems using the general (combined) gas law and state how this law relates to the transfer of energy in an air conditioning system.	2
1.2.3	Describe the construction and operation of the following vapour cycle system components: a. Blowers b. Compressors c. Condensers d. Evaporators e. Expansion valves f. Isolation valves g. Receiver-dryers h. Superheaters and subcoolers.	1
1.2.4	Describe the construction features, principles of operation, location and function within a typical system of the above components.	1
1.2.5	Describe the types and characteristics of refrigerants and oils used in an air conditioning system.	1
1.2.6	Identify and state the function of the valves, gauges, fittings and hoses of a vapour cycle servicing manifold set.	1
1.2.7	Describe the procedures and list the equipment used to carry out purging and charging of the system.	1
1.2.8	State precautions necessary for the safe servicing of a vapour cycle system.	1
1.2.9	Describe the procedures and list the equipment used to carry out leak tests, checking compressor oil and evacuating the system.	1
1.2.10	Identify and name the procedures to rectify faults in vapour cycle systems.	1
1.2.11	State the environmental requirements associated with the use of air conditioning fluids.	1

1.3	**Air Conditioning–Air Cycle System**	
1.3.1	Define the following terms: a. Adiabatic b. Conduction c. Convection d. Humidity e. Latent heat f. Latent heat of vaporization g. Radiation h. Relative humidity i. Sensible heat j. Superheat.	2
1.3.2	From given information identify the schematic relationships of the following air cycle system components and describe their operating principles: a. Air cycle machines b. Flow control valves c. Heat exchangers d. Humidifiers e. Mixing chambers f. Pressure regulation valves g. Recirculation fans h. Recirculation filters i. Silencers j. Spill valves.	2
1.3.3	Identify by name and state the function of components in a basic air cycle system.	2
1.3.4	Trace the airflow through the various schematic layouts provided, from air supply source to distribution outlet.	1
1.3.5	Describe desired airflow paths in occupied cabins.	1
1.3.6	Identify provisions for emergency and ground ventilation in a given system schematic drawing.	1
1.3.7	From given information describe the operation of a trim air system.	1
1.3.8	Describe the operating principles of gasper (eyeball) vents and systems.	1
1.3.9	Describe the operating principles of cabin temperature control systems and identify appropriate sensor locations that contribute to stable temperature control.	2
1.3.10	Describe the operation and trace airflows in given configurations including the electrical and instrument interface.	2
1.3.11	Diagnose faults in a typical air cycle system.	3

1.4	**Fuel Storage and Distribution Systems**	
1.4.1	Describe the construction, operation and maintenance of the following: a. Boost/auxiliary pumps b. Transfer valves c. Refuelling and defuelling systems.	2
1.4.2	Describe the operation of a jet pump in an aircraft's fuel system.	2
1.4.3	Describe the reasons why a jet pump is used in lieu of an electrical or mechanical driven fuel pump.	2
1.4.4	Describe the operation (electrical and mechanical) of a typical fuel system when feeding an engine and when transferring fuel between tanks.	2
1.4.5	Describe the construction, operation, function, inspection and maintenance of: a. Filters b. Fuel heaters c. Primers d. Pumps e. Strainers f. Tanks (rigid, flexible and integral) g. Valves.	1
1.4.6	Identify the location of fuel system components in a basic system including the instrument and electrical interface.	1
1.4.7	Identify the location of fuel system components in a typical system.	1
1.4.8	Describe the layout and operation of typical gas turbine engine aircraft fuel systems, including the instrument and electrical interface.	1
1.4.9	Describe the procedures for the inspection and servicing of aircraft fuel systems and components.	1
1.5	**Undercarriage Systems**	
1.5.1	Describe the operation of the electrical position indicating and control system of a typical landing gear system.	2
1.5.2	Describe the construction and operation of air/ground sensor systems.	2
1.5.3	Given electrical diagrams, diagnose faults in typical undercarriage systems.	3
1.6	**Auto-Braking and Anti-Skid Systems**	
1.6.1	Describe the construction, operation function and control of automatic braking systems.	2
1.6.2	In relation to an anti-skid system, be able to define its function and list its components.	2
1.6.3	Describe the operation of an electrical powered anti-skid system in all situations (i.e. no skid, skid and landing).	2

1.6.4	Describe system testing – ground and in-flight.	2
1.6.5	Describe typical anti-skid system maintenance.	2
1.7	**Hydraulic Systems**	
1.7.1	Describe the function, operation, location, construction, indication and control of electrically powered hydraulic pumps.	2
1.7.2	Describe the function and operation of electrically controlled hydraulic valves.	2

2.	**Power Supplies**	
2.1	**Aircraft Battery Systems**	
2.1.1	Describe a multiple battery installation and how batteries are connected to obtain desired voltages and capacities.	2
2.1.2	Describe battery-switching arrangements used to obtain desired voltages.	2
2.1.3	Describe the construction and location of aircraft battery compartments with particular regard to the following: a. Heat dissipation b. Ventilation of gasses. c. Protection of airframe structure d. Location of main and battery buses e. Battery clamping f. Battery trays g. Vents and pipes h. Vent discharge locations and venting methods including the use of pressurisation air i. Vent non-return valves j. Acid traps.	2
2.1.4	Describe the common methods of battery connection to the aircraft electrical system.	2
2.1.5	Describe the procedure and precautions associated with the connection or disconnection of batteries in an aircraft electrical system.	2
2.1.6	Describe the emergency services commonly supplied from the battery busbar.	2

2.1.7	Describe the purpose and typical location in the electrical system of the following battery components: a. Power selector switch b. Emergency power switch c. Main DC busbar d. Battery relay e. Reverse current circuit breakers f. Battery overheat isolation device g. Transformer rectifier units h. SCR switching circuits i. Power supply regulator j. Power supply monitor k. Power supply interrupt l. Power supply logic circuitry.	2
2.2	**AC Power Generation and Control (Frequency-Wild Systems)**	
2.2.1	Describe the following criteria in respect of AC power generators: a. Phasing and phase relationships b. Interconnection of phases c. Generator power ratings d. Restrictions relating to the supply of purely reactive loads.	2
2.2.2	Describe what is meant by a frequency-wild generation system with regard to the following: a. How frequency–wild power is derived b. Aircraft systems that use frequency-wild power c. Transformation and rectification of frequency-wild power d. Excitation of frequency-wild generators e. Applications of frequency-wild systems and the types of aircraft in which they would normally be found.	2
2.2.3	Describe the construction and principles of operation of a typical frequency-wild generator with particular regard to the following components: a. Rotor b. Stator and stator windings c. Output terminal block d. Protection transformer e. Excitation terminal block f. Brush gear and slip-rings g. Cooling h. Overheat warning and protection i. Casing j. End frame.	2
2.3	**AC Power Generation and Control – Constant Frequency Systems**	
2.3.1	Describe the following criteria in regard to constant speed systems: a. Purpose and use of constant frequency power b. Why constant frequency is important for multi-generator systems c. How field excitation is achieved.	2

2.3.2	Describe the construction and operation of a constant speed drive (CSD) unit with particular regard to the following: a. Power input b. Hydraulic pump c. Variable and constant displacement swash plates d. Overdrive control e. Underdrive control f. Cylinder block and pistons g. Electro-mechanical disconnect mechanisms h. Fault finding and troubleshooting i. CSD Maintenance.	2
2.3.3	Describe the construction, operation and maintenance of a typical integrated drive unit (IDG).	2
2.3.4	Describe the construction and principles of operation of a typical brushless generator with particular regard to the purpose and operation of the following components: a. Exciter shunt field and stabiliser windings b. Exciter main poles c. Exciter armature windings d. Slotted rotor e. Thermistor f. Permanent magnet g. AC stator h. Rotating field pole i. Stator frame j. Output windings k. Damper windings l. Steel band m. Copper band n. Busbar o. Diode p. Rotating field windings q. Damper bar r. Separator s. Temperature compensation t. Thermostatic switch u. Winding connection methods v. Cooling system.	2
2.3.5	State the advantages of using AC electrical power in aircraft systems.	1
2.3.6	State the advantages of using a three-phase four-wire system over a three-wire distribution system.	1

2.4	**Voltage Regulation**	
2.4.1	Describe a voltage regulation system for a frequency-wild AC generator with particular regard to the purpose and operation of the following components: a. Three phase magnetic amplifier b. Exciter rectifier c. Three phase transformer d. Signal rectifier e. Single phase error sensing magnetic amplifier.	2
2.4.2	Describe the construction and operation of a transistorised voltage regulator used in conjunction with a frequency-wild generator. Particular regard should be paid to the arrangement of transistors and the reverse current function.	2
2.4.3	Describe the method of voltage output regulation of a constant frequency system with particular regard to the purpose and operation of the following systems and components: a. Voltage error detection (sensing and reference) b. Error control winding (Pre amplifier) c. Signal control winding (Power amplifier)	2
2.4.4	In a stabilised voltage regulator, describe the relationship between output voltage, load current changes and effective impedance of the supply.	2
2.5	**Load-Sharing or Paralleling**	
2.5.1	In a frequency-wild system describe how load sharing is achieved through the use of equalizing circuits.	2
2.5.2	In a constant frequency system describe what is meant by: a. Real load b. Reactive load.	2
2.5.3	Describe how each of the above loads is expressed.	2
2.5.4	In a multi-generator, constant frequency system, describe how: a. real load sharing is achieved. b. reactive load sharing is achieved. c. Alternators are protected from shorts using a parallel busbar disconnection device.	2
2.5.5	State the factors that must be matched when an AC generator is connected in parallel to an aircraft bus.	1
2.6	**Air-Driven Generators and Ram Air Turbines**	
2.6.1	Describe where and when air-driven generators and ram air turbines may be used on large transport aircraft.	2

2.6.2	In regard to air-driven generators and ram air turbines, describe the following factors: a. Construction b. Principles of operation c. Services supplied d. Power output e. Aircraft speed limitations f. Airframe mounting g. Deployment and stowage.	2

3.	**Power Conversion Equipment**	
3.1	**Power Transformers (Potential/Parallel)**	
3.1.1	Describe the construction of a power transformer with particular regard to the following: a. Types used for single and three phase transformation b. Core characteristics c. Core Material d. Core lamination e. Core shape (L and T) f. Core clamps g. Mating of core surfaces h. Common winding materials i. Winding insulation j. Circuit connections (star/delta).	2
3.2	**Current Transformers**	
3.2.1	Describe the purpose and uses of current transformers.	2
3.2.2	Describe the construction and principles of operation of current transformers with particular regard to the following criteria: a. Turns ratio b. Primary and secondary windings c. Core materials and configuration d. Use of resin moulding e. Operating principle f. Use of multiple transformers g. Busbars.	2
3.2.3	Describe the precautions that must be taken when a current transformer is disconnected from its load circuit. State why such precautions are necessary.	2
3.3	**Auto-Transformers**	
3.3.1	Describe the purpose and common applications of auto-transformers.	2

3.3.2	Describe the construction and principles of operation of auto-transformers, with particular regard to the following: a. Circuit arrangement b. Tappings and voltage values c. Linking of the magnetic flux d. Self-induced and applied voltages e. Diameter of windings f. Connection of windings g. The effects of an open circuit in either the primary or secondary windings and precautions to be taken.	2
3.4	**Transformer Ratings**	
3.4.1	Describe the two methods of expressing transformer ratings.	2
3.4.2	Describe what is termed the regulation of a transformer and how it is expressed.	2
3.4.3	Describe the effects of changes in power supply frequency with particular regard to the following: a. Operation at a frequency below that for which the transformer was designed b. Operation at a frequency above that for which ~~a~~ the transformer was designed.	2
3.5	**Transformer Rectifier Units**	
3.5.1	Describe the purpose and common applications of transformer-rectifier units.	2
3.5.2	State the common design frequency and ratings of transformer-rectifier units.	2
3.5.3	Describe the construction and principles of operation of transformer-rectifier units, with particular regard to the following: a. Circuit layout b. Transformer c. Bridge rectifier assemblies d. Arrangement and connection of windings e. Ammeter shunt f. Grouping of terminals g. Cooling h. Temperature warning and thermal switching i. Level of resistance in forward and reverse current flow directions.	2
3.6	**Rectifiers**	
3.6.1	Describe the process of AC power rectification and identify the alternator/ rectifier arrangement that will produce the smoothest direct current output.	2
3.6.2	Describe the uses, construction and operation of the following types of rectifier: a. Semi-conductor/metal junction b. Selenium rectifier c. Silicon rectifier d. Silicon controlled rectifiers e. Triac.	2

3.6.3	Describe the operating limitations of rectifiers with particular regard to: a. Temperature limitations b. Reverse voltage limits.	2
3.6.4	Describe the principles of operation and rectifier circuit connections for: a. Single-phase half-wave rectification. b. Single-phase full-wave rectification. c. Three-phase half-wave rectification. d. Three-phase full-wave bridge rectifier.	2
3.7	**Rotary Converting Equipment**	
3.7.1	Describe the purpose, operation and construction of a rotary inverter with particular regard to the following: a. Motor construction b. Generator construction c. Cooling d. Voltage and frequency regulation e. Mounting and damping.	2
3.8	**Static Inverters**	
3.8.1	Describe the purpose, operation and construction of a static inverter with particular regard to the following: a. Filter network b. Pulse shaper c. Constant current generator d. Power driver stage e. Output stage f. Voltage and current sensor g. Feedback signal h. Notch control circuit.	2

4.	**Ground and Auxiliary Power Supplies**	
4.1	**DC Ground Power Systems**	
4.1.1	Describe the aircraft systems that are commonly powered externally by a DC ground power supply.	2
4.1.2	Describe where on an aircraft a ground power connection is commonly found.	2
4.1.3	Describe the operation and control of typical ground supply equipment including: a. DC battery carts b. DC GPU c. AC/DC GPUs d. rectifiers e. inverters.	2

4.1.4	Describe the operation of a typical ground power unit with regard to: a. Starting b. Connection c. Load monitoring d. Stopping e. Safety precautions.	2
4.1.5	Describe the construction and operation of a typical multiple DC busbar ground power supply system with particular regard to the following: a. Ground supply master switch b. Vital DC busbar c. Ground supply contactor d. Magnetic indicator e. Bus tie contactors f. Aircraft interface g. Interlocks h. Safety devices.	2
4.1.6	Describe the types/patterns, construction and operation of ground power sockets with particular regard to the following: a. Positive, and earth pins b. Pin length c. Pin shrouding.	2
4.1.7	Describe how ground power will de-energize should the ground supply socket be removed with the circuit “live”.	2
4.2	**AC Ground Power Supplies**	
4.2.1	Describe the construction and operation a typical AC ground power supply system with particular regard to the following: a. Three phase supply ground power plug b. Ground power TRU c. Ground power breakaway relay d. Phase sequence protection e. Ground power switch f. Indicating lights and meters g. DC Busbar h. Three phase AC main busbar i. Selector switch j. Control relay k. GPU/APU interface and interlocks.	2

4.3	**Auxiliary Power Units (APU)**	
4.3.1	Describe the functions and construction of a typical APU with particular regard to the following: a. Location on the aircraft b. Electrical services supplied c. Other services supplied d. Fuel supply e. Oil supply f. Load control g. Starter-generator h. Intake doors i. Accessory gearbox.	1
4.3.2	Describe the operation of a typical APU with particular regard to the following: a. Starting b. EGT Sensing c. Load control d. Acceleration limiting e. Starter duty cycle f. Typical control panel layout g. Fire protection and warning.	1

5. Measuring Instruments, Warning Indicators and Lights		
5.1	**DC Meters**	
5.1.1	Describe the functions and principles of operation of a frequency meter.	1
5.1.2	Describe the functions and principles of operation of a power meter.	1
5.2	**Warning and Indicating Lights**	
5.2.1	Describe how lights may be dimmed.	2
5.2.2	Describe the power source commonly used for warning and caution lights.	2
5.2.3	Describe the purpose and typical use of synchronising lights.	2
5.3	**Magnetic Indicators**	
5.3.1	Describe the purpose and give examples of where magnetic indicators are used on modern aircraft.	2
5.3.2	Describe the construction and operation of a typical magnetic indicator.	2

6.	**Power Distribution**	
6.1	**Electrical Wires and Cables**	
6.1.1	Distinguish between an electrical wire and an electrical cable.	2
6.1.2	Describe the construction, composition, characteristics, advantages and disadvantages of common types of wires and cables of both British and American manufacture.	2
6.1.3	Describe the methods and precautions to be observed during forming, identification, routing and securing of electrical cables in different aircraft environments.	2
6.1.4	Distinguish between an open and a ducted system.	2
6.1.5	Describe the following: a. Cable sealing techniques in pressurised aircraft b. Construction and use of pressure proof bungs and sockets.	2
6.1.6	Be able to identify the correct heat shrink material to be used and list the precautions associated with its use.	2
6.1.7	Describe the methods used to mark electrical cables and wires.	2
6.1.8	Describe the following factors relating to electrical wire: a. Insulation resistance testing, defects and rectifications b. Strand metal composition c. Strand number and diameter d. Wire gauge rating e. Voltage and current carrying capacity and rating f. Temperature characteristics g. Characteristics and uses h. Identification of wire codes i. Braiding and screening j. Calculation of voltage drop in given wiring arrangements k. Moisture sealing l. Looms m. Conduits and ducting n. Clamps and clamping methods.	2
6.1.9	Describe the advantages, disadvantages, characteristics, uses and limitations of copper and aluminium cables and wiring in aircraft electrical systems.	2
6.1.10	Describe the precautions, identification and routing associated with high-tension cable installations.	2
6.1.11	Describe the following criteria relating to coaxial cables: a. Identification b. Uses c. Methods of attaching connectors d. Testing e. Installation precautions.	2

6.1.12	Describe the construction, installation testing and handling precautions associated with thermocouple cables.	2
6.2	**Bonding, Screening and Electrical Safety**	
6.2.1	In relation to bonding and screening, be able to: a. Describe the methods employed. b. Describe the operation and safety precautions associated with the use of meggers and bonding testers. c. State precautions to be observed when creating and installing earth points. d. State the minimum acceptable standards for insulation and bonding tests. e. Identify radio interference problems associated with the inadequate bonding of electrical Components and how noise suppression may be achieved. f. Describe typical voltages associated with electrostatic discharge. g. Identify electrostatic damage. h. Describe the operation of static wick dischargers. i. Describe the construction and location of DC/ACIRF earths.	2
6.2.2	Describe the environmental effects that electrical systems and components may be exposed to and how protection can be afforded.	2
6.2.3	Identify the personal dangers associated with electrical systems and describe the voltage/current levels and conditions that would constitute a hazardous situation.	2
6.3	**Power Distribution Systems and Associated Components**	
6.3.1	Describe, with examples, the classification of aircraft power service requirements into the following categories: a. Vital b. Essential c. Non-essential.	2
6.3.2	Using the appropriate terminology describe the construction, operation and uses of the following components: a. Split bus system b. Parallel bus system c. Load shedding system d. Priority bus system e. Emergency bus f. Battery bus g. Ground power bus.	2
6.3.3	Describe the purposes of the various bus switching components.	2
6.3.4	Be able to troubleshoot typical aircraft split, parallel and emergency bus systems.	2
6.3.5	Describe the operation of generator equalising circuits and be able to troubleshoot a typical system.	2

6.3.6	Be able to state the purpose of overvoltage/undervoltage and reverse current protection.	1
6.3.7	Describe the operation of, and be able to diagnose, typical faults in circuits designed to give reverse current protection.	3
6.3.8	Describe the construction, contents, mounting, bonding, earthing, inspection and testing of a typical electrical junction box.	2

7.	**Circuit Controlling Devices**	
7.1	**Electrical Control Devices**	
7.1.1	With regard to the following devices, be able to define related terminology, describe the operation, state the uses and limitations and identify them on drawings: a. Switches, single and multi-pole/throw varieties b. Toggle and tumbler switches c. Push-switches d. Rocker button switches e. Rotary (roller) switches f. Micro-switches g. Rheostats h. Time switches i. Mercury switches j. Pressure switches k. Thermal switches l. Proximity switches m. Limit Switches n. Attracted-core heavy-duty relays o. Attracted armature light-duty relays p. Polarized armature relays q. Slugged relays r. Solenoids s. Magnetic amplifiers.	2
7.1.2	Describe the operation, maintenance, testing, typical defects and rectification associated with the above relays, switches rheostats and solenoids.	2

8.	**Circuit Protection Devices**	
8.1	**Reverse Current Protection**	
8.1.1	Describe the construction, operation, identification, limitations and precautions relating to: a. Reverse current cut-out relays b. Reverse current circuits breakers.	2

8.2	**Voltage Protection**	
8.2.1	Describe the purpose, construction, operation, identification, limitations and precautions relating to the following voltage protection devices: a. Over-voltage protection b. Under-voltage protection c. Under-frequency protection d. Over-frequency protection e. Merz-Price protection system.	2

9. Power Utilisation Components		
9.1	**Aircraft Lighting**	
9.1.1	Describe the operation, control, layout and testing of typical aircraft lighting systems. (both internal and external).	2
9.1.2	Describe the purpose, construction, operation, maintenance and safety precautions associated with various types of external aircraft lights, such as: a. Navigation lights. b. Anti-collision lights. (rotating and flashing) c. Strobe lights. d. Landing lamps. e. Taxi lamps. f. Ice inspection lamps. g. Area inspection lights h. Logo lights	2
9.1.3	Describe the purpose, construction, operation and maintenance of the various types of internal aircraft lighting, such as: a. Cockpit area lighting. b. Flood-lighting. c. Instrument panel lights. d. Integral instrument lighting. e. Post and bridge lighting. f. Trans-illuminated panels. g. Electroluminescent lighting. h. Passenger cabin lighting. i. Passenger instructional lighting. (no smoking and fasten seatbelts) j. Strip lighting. k. Passenger service unit lighting. l. Cargo compartment lighting.	2

9.1.4	Describe the purpose, construction, operation and maintenance of the following emergency lighting and lighting components: a. Crash inertia switches b. Floor proximity emergency escape path lighting c. Emergency exit lighting.	2
9.1.5	Given circuit diagrams, diagnose faults in typical lighting and dimming control circuits.	3
9.2	**Electrical Load Analysis**	
9.2.1	Describe the purpose of an electrical load analysis.	2
9.2.2	Be able to determine when an electrical load analysis is required and be able to carry out an analysis as prescribed in CAR for an aircraft electrical system.	3
9.2.3	Identify Class 1 and Class 2 circuits and state the operating conditions and precautions that apply to each.	2
9.3	**Alternating Current (AC) Motors**	
9.3.1	Using the relevant terminology be able to describe the uses, construction, operation and characteristics (starting and running) of the following types of motor: a. Single-phase b. Two-phase c. Three-phase d. Induction e. Synchronous motors of various types.	2
9.3.2	Determine the direction of rotation using the right hand rule for motors.	3
9.3.3	Determine the RPM of induction and synchronous motors using the formula RPM = 60f/p.	3
9.3.4	Describe the following methods of producing a rotating field: a. Capacitor. b. Inductor. c. Shaded or split pole.	2
9.3.5	Describe the method of reversing the direction of rotation of an AC motor.	2
9.4	**AC Actuators**	
9.4.1	Describe the use, construction, principles of operation, maintenance and adjustment of the following motor actuators and associated components: a. Linear actuators b. Rotary Actuators c. Actuator gearing d. Limit switches e. Brakes f. Clutches.	2

10. Power Utilization Systems		
10.1	**Gas Turbine Engine Fuel Control and Metering Systems**	
10.1.1	Describe the basic requirements, arrangements and principles of operation of gas turbine engine fuel control/metering systems including the following: a. Acceleration scheduling b. Air density/altitude/OAT/airspeed compensation c. Overspeed governing d. Power limiting e. Shutdown control f. Starting control g. Temperature limiting.	1
10.1.2	Describe the relationship, location and function of the following gas turbine engine fuel control system components: a. Engine sensing variables. b. Fuel control unit (hydro-pneumatic, hydro-mechanical & electro-mechanical). c. Fuel filters (HP and LP). d. Fuel heaters. e. Governors and limiter devices. f. Main fuel pumps (HP and LP). g. Valves (throttle/dump/shutoff).	1
10.2	**Gas Turbine Engine Air Systems**	
10.2.1	Describe the basic requirements, arrangements and principles of operation of gas turbine engine air distribution and anti-ice control systems, including the following: a. Internal cooling b. Sealing c. External air services.	1
10.2.2	Describe the relationship, location and operation of: a. Air distribution/external services components. b. Air starting system components. c. Anti-icing system components. d. Engine internal cooling/sealing system components.	1

10.3	**Starting and Ignition Systems**	
10.3.1	Describe the basic requirements, arrangements, principles of operation, maintenance, testing and troubleshooting of the following typical engine starter systems and components: a. Air turbine starters b. Electric starters c. Pressure regulating and shut-off valves d. Starter-generators e. Starter relays f. Clutches and overrun devices. g. Engagement mechanisms	2
10.3.2	Describe a typical start sequence in regard to the functioning of the starter and ignition circuits.	2
10.3.3	Describe what is meant by “self-sustaining” engine speed.	2
10.3.4	Describe the basic requirements, arrangements, principles of operation maintenance and testing of the following engine ignition systems and components: a. Harnesses b. High tension spark igniter plugs c. Low tension spark igniter plugs d. Glow plug igniters.	2
10.3.5	Describe the safety requirements during servicing and maintenance of engine ignition systems.	2
10.3.6	Identify the effects of faults in components on engine starting and ignition systems.	2
10.3.7	Describe why turbine engine ignition systems require high electrical energy for their operation.	1
10.3.8	Describe the operation and layout of high-energy ignition units (HEIU) both DC and AC powered.	2
10.3.9	Describe the operation and layout of: a. An intermittent duty low tension ignition unit with DC input. b. An extended duty low tension ignition system. c. A high tension intermittent duty AC input system. d. An auto-ignition system. e. A continuous-duty circuit.	2
10.3.10	Describe the advantages and limitations of: a. AC verses DC input systems. b. High tension versus low tension systems.	2

10.4	**Power Augmentation Systems**	
10.4.1	Describe the basic requirements, arrangements and principles of operation of the following gas turbine power augmentation systems and components: a. Water injection b. Water/methanol injection c. Afterburners.	1
10.5	**Engine Controls**	
10.5.1	Describe the basic requirements, arrangements and principles of operation of the following engine controls: a. Linkages and controls to and from the propeller co-ordinator/interconnector and fuel control unit b. Linkages and controls to and from the collective throttle and fuel control unit c. Mechanical control inputs and outputs for electronic fuel control systems d. Throttle/power/condition levers, cables and linkages e. Units and components interconnected for emergency shut-down.	1
10.5.2	Describe the relationship, location and function of engine mechanical control system units and components.	1
10.5.3	Describe the relationship, location and function of a supervisory electronic engine control (EEC) system both digital and analogue.	2
10.5.4	Describe the relationship, location and function of a full authority digital electronic control (FADEC) system.	2
10.5.5	Describe the function and operation of electrical engine temperatures and speed limiting systems.	2
10.6	**Turbo-Propeller Control Systems**	
10.6.1	Describe the function, operation and maintenance of a propeller: a. Synchroniser system. b. Synchrophaser system.	2
10.6.2	List the components that comprise each system and their location within each of the systems.	1
10.6.3	Describe the function, operation and testing of electric propeller feathering systems.	2
10.7	**Ice and Rain Protection Systems**	
10.7.1	Describe the effects icing has on the operation/performance of an aeroplane and the difference between anti-ice and de-icing systems.	2
10.7.2	Describe the layout, operation, maintenance (including safety precautions) and troubleshooting of engine, propeller and airframe anti-ice protection systems, including: a. Electro-pneumatic de-ice systems. b. Propeller ice protection systems.	2
10.7.3	Describe the operation of various types of ice detecting devices and temperature control methods.	2

10.7.4	Describe the electrical components, layout, operation, power requirements, maintenance, troubleshooting, defects/failure, ground operating precautions, overheat indications and protection associated with a typical electrically heated windscreen anti-icing system.	2
10.7.5	Describe the operation and system layout of various types of the following windscreen rain removal/repellent systems: a. Wipers b. Repellent (chemical) c. Hot air (Pneumatic).	1
10.7.6	Describe the requirements for ground de-icing and the precautions associated with the use of de- ice chemicals.	2
10.7.7	Describe the operation of a typical waste water and toilet drain heating system.	2
10.7.8	Describe the construction, operation, maintenance, testing and troubleshooting of propeller electric de-icing overshoes and their supporting electrical systems.	2
10.7.9	Describe the construction, operation, maintenance, testing, troubleshooting and precautions associated with anti-icing the following components and describe their supporting electrical systems: a. Pitot head b. Static port c. Angle of flow d. Temperature probes e. Antenna f. Ice warning and sensing devices.	2
10.8	**Cabin Heating**	
10.8.1	Describe the construction, operation and maintenance of a typical combustion heater and troubleshoot a typical system.	2
10.8.2	Describe the construction and operation of electrical cabin heating and temperature control systems.	2
10.9	**Fire Detection and Extinguishing Systems**	
10.9.1	Describe the fire triangle.	1
10.9.2	Describe the construction, wiring, operation, testing, troubleshooting, maintenance and advantages/disadvantages of the following types of fire detection system: a. Continuous element or pressure type sensor responder. b. Continuous loop (fire wire) (Fenwal and Kidde) c. Thermal switch. d. Thermocouple. e. Infra-red. f. Fenwal spot detector.	2

10.9.3	Describe the operation, layout, troubleshooting, maintenance and safety precautions of a typical aircraft fire extinguishing systems and components. (includes the "two-shot" system).	2
10.9.4	Describe typical fixed fire extinguishing systems.	2
10.9.5	Describe the contents, location and use of typical portable fire extinguishers.	1
10.9.6	Describe the inspection and maintenance requirements for both detection and extinguishing systems.	2
10.9.7	Describe the safety precautions to be observed when dealing with aircraft fire extinguishing systems including the handling of explosive cartridges (Squibs).	2
10.9.8	Describe the properties of extinguisher agents in relation to types of fire, toxicity and clean-up.	2
10.10	**Smoke Detection**	
10.10.1	Describe the construction and operation of the following smoke detection systems: a. Carbon monoxide b. Photoelectric c. Visual d. Infra-red.	2
10.10.2	Describe typical fire and smoke cockpit warning indications including: a. Lights. b. Bells. c. Annunciator panels. d. Audio warnings.	2
10.11	**Flight Controls**	
10.11.1	Describe the construction, principles of operation, protection, control and maintenance of the following flight control components: a. Power control units (PCU) b. Flap motors c. Trim motors d. Position indicators.	2
10.12	**Galley and Toilet Service Systems**	
10.12.1	Describe the operation, safety devices and control of service power supplies for the equipment and systems associated with: a. Water heaters b. Ovens c. Toilets.	2