AIRCRAFT MAINTENANCE ENGINEER TRAINING SYLLABI

Globally, the knowledge and skills required to maintain aircraft and aircraft components have been documented by bodies responsible for international [training] standards.

Based on *"international training standards"* promulgated by the *International Civil Aviation Organisation* (ICAO) in their Annex 1 Chapter 4 referenced training manual, the following avionics syllabi adopts the referenced *Aircraft Maintenance Engineer* (AME) training standards that meets Australia's obligation under Article 37 of the Convention.

> *"8.7.6.3 The competence of maintenance personnel **shall** be established in accordance with a procedure and to a **level acceptable to the State** granting the approval. The*

Article 37 of the Convention and these Annexes' provisions gives CASA the right to promulgate the ICAO international AME training standards syllabi. In addition, it has the right to state the syllabi pathway, based on the ICAO training manual, for an applicant to meet prior to applying for each CASA licence.

> ***ICAO Doc 7192 Part D1**. For this reason, the syllabi of instruction for the training of AMEs should be developed based on the specifications outlined in Chapters 2 to 13 of this manual. (Chap 4, can be pre-employment, Chap 3 LAME specific, Chap 5-12 AME.)*

The avionics trade level syllabi is based on Chapters 7, 8 & 12 and the mechanical syllabi is based on Chapters 5, 6, 10 & 11. Chapter 3 syllabi needs to be achieved to obtain an AME licence.

These syllabi are trade specific training standards and are underpinned by the general syllabi for all AMEs specified in Chapters 4 & 9. Chapter 4 relates to the Natural Sciences and should be the entry standard to trade training mentioned above, and Chapter 9 relates to Human Factors associated with trade levels.

The government has allocated Annexes 1, 6 & 8 compliance to CASA. However, within those Annexes, the government has also made the Education Department responsible for providing competencies and "qualifications" under the NVET system. Therefore CASA's important input is to promulgate these "international training standards" so the Education Department has an aviation regulatory input when providing competencies and qualifications.

CASA's role is to promulgate the Annex 1 "standards" – it is not CASA's role to be liable for the Education Department's responsibility to develop training packages that underpin AME academic "qualifications" that is the responsibility of the Education Department's Aerospace Industry Reference Committee. These "qualification" will be seen as internationally equivalent if the services of ***Trades Recognition Australia*** are used.

> The Education Department's "Trade Recognition Australia": "*Trades Recognition Australia (TRA) is a **skills assessment service provider specialising in assessments for people with trade skills gained overseas or in Australia**, for the purpose of migration and skills recognition*."

This Federal government has committed to funding AME apprenticeship training to the ICAO international training standard. This funding is needed to support RTO's providing the training. The majority of State funding comes from the Federal Government for vocational training. Some States have additional funding but they will not fund this training alone.

Without AME training standards, we end up in the mess we have today. Trade training must be broader than an AME licence scope to provide flexible transportable skills and qualification.

Doc 7291 Part D1, Chapters 7/8/12 Syllabi. AME Avionic Trade Skills

Knowledge & Practical Training Underpinning B2 Licence

7.3. Maintenance Practices and Materials: Avionics

7.3.1. Aircraft and workshop safety precautions

- A guide to the various aspects of safe working practices, including precautions to be taken when working with electricity, gases, oils and chemicals
- Instruction in the remedial action to be taken in the event of an accident with one or more of the hazards

7.3.2. Principles of workshop practices

- Care of tools
- Use of workshop materials
- Dimensions and standards of workmanship

7.3.3. General purpose tools

- Review of types of tools: hammers, mallets, screwdrivers, wrenches (spanners), torque wrenches, punches, hacksaws, clamps, vices and presses, snips and nibblers, chisels, files, reamers, taps and dies, drill bits, thread gauges, strippers, crimping tools, grease guns, oil cans, and lubricating syringes

7.3.4. General purpose power tools

- Electric and pneumatic-powered saws, drills, grinders, sanders, routers, nibblers, riveting guns and heat guns

7.3.5. Precision measuring tools

- Micrometers: metric and inch, vernier gauge, vernier calipers, surface table and accessories, marking out, dial test indicators, go/no-go gauges, combination sets, bore and depth gauges, steel rule, inside and outside calipers, slip gauge and feeler gauge

7.3.6. Screw threads

- Screw nomenclature
- Thread forms, dimensions and tolerances for standard threads used in aircraft
- Measuring screw threads

7.3.7. Bolts, studs, screws and fasteners

- Bolt types: specification, identification and marking of aircraft bolts, Society of Automotive Engineers (SAE), and metric
- Nuts: self-locking, anchor and standard types
- Machine screws: aircraft specifications
- Studs: types and uses, insertion and removal
- Woodscrews, cotter pins, self-tapping screws and nuts, and dowels

- Locking devices: tab and spring washers, locking plates, split pins, pal-nuts, wire locking, quick release fasteners, keys, circlips and turnbuckles

7.3.8. Fits and clearances

- Allowances and tolerances, drill sizes for bolt holes, and classes of fits
- Common system of fits and clearances
- Schedule of fits for avionics systems installation
- Limits for bow, twist and wear

7.3.9. Engineering drawings and diagrams

- Understanding of the following drawing types and diagrams, their symbols, dimensions and tolerances:
- Orthographic; isometric; oblique; perspective; electrical; block; schematic; sectional; blueprint; logic flow chart;
- Identification of the following information from the title block:
  - drawing and revision number; reference number; scale; weight
- Understanding of the use of maintenance data in Specification 100 and 2100 of the Air Transport Association (ATA) of America

7.3.10. Electrical cables and connectors

- Wire types: insulation, strand metal composition, strand number and diameter, wire gauge rating, voltage and current-carrying capacity and rating, temperature characteristics, uses, identification of wire codes, and braiding
- High-tension cables: precautions, identification, and routing
- Coaxial cables: identification, uses, methods of attaching connectors, testing, and installation precautions
- Crimping: types of crimp ends, in-line, lug, bayonet, wrist joint, blind end, and terminal
- Identification of crimps: colour code, identification marks, insulation grip, wire grip, and crimp form
- Testing of crimp joints: millivolt drop test, crimp pull test, etc.
- Crimp tools: types, colour codes, ratchet devices, jaws and chucks, testing and go/no-go gauges
- Connector types, pins, pin removal and insertion, insertion and removal tools, plugs, sockets, insulators, current and voltage rating, coupling, and identification codes

7.3.11. Soldering

- Soldering irons: types, sizes and uses
- Solder: tin/lead content, melting point, and chemical combinations
- Flux: types, uses and purpose of flux, core flux, flux removal, flux corrosion and flux temperatures
- Special solder for non-ferrous metals
- Soldering techniques
- Anti-static considerations when soldering
- Heat shunts and de-soldering
- Dry joints and soldering defects

7.3.12. General test equipment for avionics

- Operation, construction, functions and uses of the following: AC and DC voltmeters, ammeters, ohm- meters, multimeters, bonding testers, Meggers, decade boxes, attenuators, frequency meters, watt/meters, Wheatstone bridge, volt amps reactive (VAR) meter, logic probe, cathode ray oscilloscope (CRO), dummy loads, audio frequency (AF) and radio frequency (RF) output power meters, voltage standing wave meter (VSWR), spectrum analyser, and AF/RF signal generators

7.3.13. Aerodynamics

- Atmosphere, pressure, temperature, humidity and density
- Newton's Laws of Motion, general gas laws, and Bernoulli's Theorem
- Airflow in relation to a body, steady or moving
- Aerofoils, shape and aspect ratio, and pressure distribution
- Lift, weight, thrust and drag
- Conditions of flight, centre of gravity, loads and forces
- Flight stability: longitudinal, lateral and directional
- Slip and skid
- Control surfaces: elevators, ailerons, rudders, elevons, ruddervators, stabilators and canards
- Boundary layer control: aerodynamic balancing
- Considerations and factors affecting high speed and supersonic flight

7.3.14. Aircraft handling

- Aircraft towing: safety precautions, towing arm types, weak links, locking devices, weight and balance limits, turn angle limits, aircraft brake control, lookouts, tugs and tractors
- Aircraft jacking: principles of aircraft jacking, safety precautions, weight and balance limits, jack types, jacking points and jacking techniques

7.4. Electrical and Electronic Fundamentals:

7.4.1. Electron theory

- Structure and distribution of electrical charges within atoms, molecules, ions and compounds
- Molecular structure of conductors, semiconductors and insulators

7.4.2. Static electricity and conduction

- Static electricity and distribution of electrostatic charges
- Electrostatic laws of attraction and repulsion
- Units of charge
- Coulomb's Law
- Conduction of electricity in solids, liquids, gases and in a vacuum

7.4.3. Electrical terminology

- Definition of the following terms, their units and the factors affecting them:
  - potential difference
  - electromotive force
  - voltage
  - current
  - resistance
  - conductance
  - charge
  - conventional current flow
  - electron flow
- Definition of the following units and conversion from one unit into another unit: giga-, mega-, kilo-, milli-, micro-, nano-, pico-, and degrees (Fahrenheit, Celsius/ Centigrade and Kelvin)

7.4.3. Generation of electricity and heat

- Production of electricity by the following methods: light, heat, friction, pressure, chemical action, magnetism and motion
- British Thermal Unit: calorie, specific heat and latent heat
- Heat transfer, convection, conduction and radiation
- Thermal expansion
- Coefficient of linear expansion
- Bimetallic strips

7.4.4. Generation of electricity and heat

- Production of electricity by the following methods: light, heat, friction, pressure, chemical action, magnetism and motion
- British Thermal Unit: calorie, specific heat and latent heat
- Heat transfer, convection, conduction and radiation
- Thermal expansion
- Coefficient of linear expansion
- Bimetallic strips

7.4.5. DC sources of electricity

- Construction and basic chemical action of the following: primary cells, secondary cells, lead acid cells, nickel cadmium cells and other alkaline cells
- ells connected in series and in parallel
- Internal resistance and its effect on a battery
- Construction, materials and operation of thermocouples

7.4.6. DC circuits

- Ohm's Law
- Kirchoff's Voltage and Current Laws

- Calculations to find resistance, voltage and current by using Ohm's Law, Kirchoff's Voltage and Current Laws, etc.
- Significance of the internal resistance of a supply

7.4.7. Resistors and resistance

- Resistance and affecting factors
- Specific resistance
- Positive and negative temperature coefficient conductance
- Fixed resistors including their stability, tolerance and limitations: carbon composition, carbon film, wire wound, and metallic film
- Variable resistors: wire wound, carbon film, thermistors, voltage dependent resistors and varistors
- Resistor colour code, values and tolerances, preferred values, and wattage ratings
- Resistors in series and in parallel
- Calculation of total resistance by using series, parallel and series-parallel combinations

7.4.8. Power

- Dissipation of power by a resistor
- Power, work and energy (kinetic and potential)
- Conversion of horsepower to watts and vice versa
- Power formula
- Maximum power transfer theorem
- Calculations involving power, work and energy

7.4.9. Rheostats and potential dividers

- Construction, operation and use of potentiometers and rheostats, and the effect of varying the load on the output voltage
- Construction and operation of Wheatstone bridge
- Polarities of potential differences in resistive circuits

7.4.10. Capacitors and capacitance

- Principles of the operation and function of a capacitor
- Factors affecting the capacitance area of plates, distance between plates, number of plates, dielectric and dielectric constant
- Units of capacitance and their interrelationships
- Working voltage, voltage rating, and relationship between capacitance and working voltage
- Construction and function of the following capacitors: paper, mica, ceramic, electrolytic and tantalum
- Capacitor colour coding and preferred values
- Variable capacitors: air and solid dielectric
- Calculations of capacitance and voltage in series and parallel circuits
- Exponential charge and discharge of a capacitor, and time constants
- Testing of capacitors using an ohmmeter for short circuit, open circuit, and leaky capacitor

7.4.11. Magnetism

- Properties of a magnet
- Theory of magnetism, molecular and domain
- Laws of attraction and repulsion
- Action of a magnet suspended in the earth's magnetic field
- Magnetization and demagnetization
- Artificially-made magnets
- Magnetic shielding
- Various types of magnetic material
- Electromagnets: construction and principles of operation
- Hand-clasp rules to determine magnetic field around current-carrying conductor: north and south poles; the direction of current flow through a coil
- Factors affecting field strength in electromagnets
- Magnomotive force (MMF): field strength (H), magnetic flux density (B), permeability, B/H curves, hysteresis loop, retentivity, coercive force, reluctance, saturation point, and eddy currents
- Precautions for care and storage of magnets

7.4.12. Inductors and inductance

- Faraday's Law
- Action of inducing a voltage in a conductor moving in a magnetic field
- Effects of the following on the magnitude of an induced voltage:
  - magnetic field strength
  - rate of change of flux
  - the number of conductor turns
- Mutual induction
- Effect of the rate of change in primary current and of mutual inductance on induced voltage
- Factors affecting mutual inductance:
  - number of turns in coil
  - physical size of coil
  - permeability of coil
  - position of coils with respect to each other
- Unit of inductance
- Lenz's Law and the rules determining polarity
- Back electromotive force (EMF) and self-induction
- Calculation of total inductance in series, parallel and series-parallel circuits
- Inductive resistive circuit: functions and time constants
- Saturation point
- Principal uses of inductors
- Construction and functions of fixed inductors: laminated iron core, iron dust core, air core and ferrite core
- Methods of varying inductor value: tapped coil, slider contact on coil, adjustable slug, and variometer
- Testing inductors for faults, open circuit coil, and shorted turns

7.4.13. DC motor/generator theory

- Construction and purpose of components in DC generator
- Operation of and factors affecting output and direction of current flow in DC generators
- Operation of and factors affecting output power, torque, speed and direction of rotation of DC motors
- Series wound, shunt wound and compound motors

7.4.14. AC theory

- Analysis and terms related to sinusoidal waveform: radian, angular velocity, phase, period, frequency and cycle
- Harmonic: effects of even and odd harmonics on fundamental waveform
- Current and power calculations of the following values in relation to voltage: instantaneous, average, root mean square, peak and peak-to-peak

7.4.15. Resistive (R), capacitive (C) and inductive (L) circuits

- Phase relationship of voltage and current in L, C and R circuits: parallel, series and series-parallel
- Power dissipation in L, C and R circuits
- Factors affecting inductive and capacitive reactance
- Calculations of inductive and capacitive reactance
- Impedance, phase angle, power factor and current calculations
- Calculations of true power, apparent power and reactive power

7.4.16. Series and parallel resonance

- Definition of resonance
- Changes in circuit properties at resonance of parallel- and series-tuned circuits
- Effects of circuit prior to and after resonance
- Effects on impedance, current and phase angle when frequency of a series or parallel resonant circuit is varied
- Frequency response curves for series and parallel resonant circuits
- Voltage magnification factor (Q) of a circuit
- Effects of resistance on circuit "Q" and resonance curves
- Calculation of circuit resonant frequency
- Calculation of bandwidth
- Operation and use of tank circuit

7.4.17. Transformers

- Operation of transformer
- Transformer: losses and methods for overcoming them
- Transformer action under load and no-load conditions
- Power transfer, efficiency, and polarity markings
- Calculation of primary and secondary current, primary and secondary voltage, turns ratio, power, and efficiency
- Auto transformers and variacs

7.4.18. Filters

- Operation, application and uses of the following filters: low pass, high pass, band pass and band stop
- Interpretation of filter response curves
- Function of and differences between active filters and passive filters

7.4.19. AC generators

- Rotation of loop in a magnetic field and the waveform produced
- Principles, operation and construction of revolving armature and revolving field type AC generators
- Single-phase, two-phase and three-phase alternators
- Three-phase star and delta connections: advantages and uses
- Calculation of line and phase voltages and currents
- Calculation of power in three-phase system

7.4.20. AC motors

- Construction, principles of operation and characteristics of AC synchronous motors and induction motors (both single and polyphase)
- Methods of speed control and direction of rotation
- Methods of producing a rotating field: capacitor, inductor, shaded or split pole

7.4.21. Signal processing devices

- Principles, operation and uses of the following signal processing devices: summing networks or points, integrators, limiters, modulators, demodulators, adders and subtracters

7.4.22. Servo-mechanisms

- Understanding of the following terms:
- open and closed loop; follow-up; servo-mechanism; analogue; transducer; null; damping; feedback; dead band; hunting
- Construction, operation and uses of the following synchro-system components:
- Resolvers; differential; control; torque; E and I transformers; inductance transmitters; capacitance transmitters
- Control and displacement: rate/rate, rate/displacement, displacement/rate, and displacement/displacement
- Servo-mechanism defects, reversal of synchro leads, and hunting

7.4.23. Semiconductors (diodes)

- Materials (silicon and germanium): electron configuration, crystalline structure, and electrical properties
- P and N type materials: effects of impurities on conduction, doping process to produce P and N type materials, majority and minority characters
- PN junction in a semiconductor
- Development of a potential across a PN junction in unbiased, forward biased and reverse biased conditions
- Diodes: symbols
- Characteristics of diodes: ideal, silicon, germanium and Zener
- Parameters of diodes: peak inverse voltage, maximum forward current, temperature, frequency, leakage current, and power dissipation
- Diodes in series and in parallel
- Zener effect
- Operation and function of diodes in the following circuits: clippers, clampers, full- and half-wave rectifiers, bridge rectifiers, voltage doublers and triplers (multipliers)
- Testing of diodes with an ohmmeter
- Operation and characteristics of the following devices: tunnel diode, silicon controlled rectifier (SCR), light emitting diode (LED), Shockly diode, photo conductive diode, varactor diode, varistor, Shottky barrier diode, diacs and triacs

7.4.24. Semiconductors (bipolar junction transistors)

- Construction and operation of PNP and NPN transistors
- Base, collector and emitter junctions
- Transistor parameters: IB, IC, IE, beta, alpha, Vbe, power gain, distortion and saturation, input and output impedance, and frequency response
- Diagrammatical symbols for PNP and NPN transistors
- Amplification, current voltage and power
- Temperature effects on transistors
- Biasing required to operate a transistor as a switch, class A amplifier, class B amplifier and class C amplifier
- Characteristics of the following amplifiers: class A, class B and class C
- Methods of bias stabilization: negative feedback, temperature stabilization resistor, thermistor, diode and transistor
- Transistor configurations, operation and characteristics of the following: common base, common collector and common emitter
- Transistor data sheets: interpretation of specification
- Identification of standard transistor package forms
- Testing transistors by using an ohmmeter

7.4.25. Types of transistor

- Characteristics, operation and application of the following devices:
  - injunction transistor; programmable injunction transistor; opto isolator; power transistor; photo transistor; small signal transistor; hall effect devices

7.4.26. Field effect transistors (FET)

- Operation, characteristics and basic circuit configuration of the following FET:
  - junction (JFET)
  - metal oxide silicon (MOSFET)
  - insulated gate (IGFET)

7.4.27. Operational amplifiers (OPAMP)

- Operation and function of an operational amplifier used as:
  - an integrator; a differentiator; a voltage follower; a comparator;
- Parameters of OPAMP:
- open loop gain; bandwidth; slew rate; input and output impedance; drift; input offset voltage and current
- Operation and function of the following amplifiers:
- inverting amplifier; non-inverting amplifier; summing amplifier; differential amplifier
- Operation and connecting methods of amplifier stages:
  - resistive capacitive (RC); inductive (transformer); inductive resistive (IR)
- Advantages and disadvantages of positive and negative feedback

7.4.28. Transistor circuits

- Operation and characteristics of the following circuits:
  - push-pull amplifiers; darlington pairs; complementary symmetry configuration

7.4.29. Multi-vibrators and oscillators

- Characteristics and operation of the following multi-vibrators:
  - astable or free running; bistable or flip-flop; monostable or one shot
- Operation and function of the following transistor and FET oscillators:
- Hartley; colpitts; resistive capacitive (RC); inductive capacitive (IC); crystal

7.5 Digital Techniques, Computers and Associated Devices:

7.5.1. Decimal to binary conversion

- Comparison of decimal and binary numbering systems
- Conversion of decimal into binary, and vice versa
- Addition and subtraction of binary numbers

7.5.2. Octal and hexadecimal conversion

- Conversion of decimal into octal and hexadecimal, and vice versa

7.5.3. Signed numbers

- Conversion of positive and negative numbers into their 1's and 2's compliment

- Addition of numbers in the 2's compliment

7.5.4. Digital calculation
- Addition and subtraction in binary coded decimal (BCD) and hexadecimal forms
- Conversion of hexadecimal numbers into 2's compliment form

7.5.5. Logic circuits
- Expression of logic diagrams in terms of Boolean algebra
- Conversion of Boolean algebraic expressions
- Identification of logic circuits
- Identification of the following logic gates symbols, their truth tables and equivalent circuits:
- AND; NAND; OR; NOR; EXCLUSIVE OR; INVERTER

7.5.6. Flip-flop terminology and operation
- Understanding of the following flip-flop terms:
  - set up and hold times; asynchronous input; synchronous input; transition (positive and negative); propagation delay; maximum clock frequency;
- Symbols used to indicate clocked inputs and negative going transition (NGT)
- Operation and identification of symbols and truth tables for the following types of flip-flop: SC or RS, JK, and D type
- Operation and application of digital counters, shift registers, and data storage devices
- Operation, advantages and disadvantages of serial and parallel data transfer

7.5.7. Data conversion
- Operation and application of analogue to digital, and digital to analogue converters, inputs and outputs, and limitations of various types

7.5.8. Computer-related terminology
- Understanding of the following computer-related terminology:
  - Bit; Byte; address; nibble; operand; op code; label; software; accumulator; mnemonic; hardware; firmware; instruction; instruction word; language; machine language; CPU (central processing unit)

7.5.9. Basic microcomputers
- Operation, layout and interface of the major components in a microcomputer, including their associated bus systems
- Information contained in single and multi-address instruction words

7.5.10. Memory devices
- Understanding of the following memory-associated terms:
  - memory cell; memory word; capacity; read option; write option; access time; cycle time
- Operation of typical memory devices during READ and WRITE modes
- Operation, advantages and disadvantages of the following data storage systems: magnetic disk, magnetic bubble, magnetic core and magnetic tape

7.5.11. Integrated circuits (IC)
- Operation and use of encoders and decoders
- Function of the following encoder types:
  - binary coded decimal (BCD) to decimal or (4 ~o10); binary to octal or (1 to 8); octal to binary or (8 to 3); priority encoders
- Understanding of the uses of:
  - medium scale integration (MSI); large scale integration (LSI); very large scale integration (VLSI)

7.5.12. Displays
- Function and operation of the following types of display:
  - liquid crystal display (LCD); LED; Nixie tube; gas discharge

7.5.13. Multiplexers, de-multiplexers and tristate devices
- Operation, application and identification in logic diagrams of multiplexers, de-multiplexers and tristate devices

7.5.14. Microprocessors
- Understanding of the overall operation and functions performed by a microprocessor
- Basic operation of each of the following micro- processor elements:
  - control and CPU; clock; register; arithmetic logic unit (ALU)

7.5.15. Encoding and decoding

- Understanding of binary coded decimal (BCD), excess 3, and grey codes and their uses in converting binary and decimal numbers
- Understanding of the structure and uses of the ASCII code
- Understanding of the use of the parity method of error detection
- Information transmission via data buses, including various bus languages used by interconnecting systems

7.5.16. Cathode ray tubes (CRT)

- Principles of electrostatic and magnetic deflection as applied to cathode ray tubes
- Construction and basic operation of monochromatic and colour tubes
- Understanding of the following terms:
  - raster scanning; stroke pulse scanning; rho-theta and X-Y screen formats; interface scanning

7.5.17. Electrostatic sensitive devices (ESD)

- Sources of electrostatic sensitive devices (ESD) and the type of damage that static electricity can cause
- Special handling, identification, packaging, and protection requirements for ESD
- Personal anti-static protection devices
- Awareness of dangerous situations where there is a possibility of static charge build-up

7.5.18. Fibre optics

- Advantages and disadvantages of fibre optic data transmission over electrical wire propagation
- Fibre optic data bus
- Understanding of the following terms and effects relating to fibre optics:
  - absorption; attenuation; active medium; black body; coherent light; coherent bundle; dark current; diffraction; dopant; dispersion; flux rise time; LED; multimode fibres; optical attenuators; signal-to-noise ratio; fibre data bus; bit rate; two-state modulation;
- Topology: passive star, active star and transmissive star
- Terminations: cleaving, stripping, splicing, and termination losses
- Couplers, control terminals and remote terminals
- Application of fibre optics in aircraft and systems

7.5.19. Software management control

- Awareness of the necessary restrictions, airworthiness requirements and possible catastrophic effects of unapproved modifications or alterations to manufacturers' software programmes

7.6. Aircraft Electrical Systems:	7.7. Aircraft Instrument Systems:
7.6.1. Power supplies: Lead acid batteries • Plate materials, insulators, electrolyte, casing, terminals, specific gravity, capacity and capacity testing, determination of state of charge, constant current charging and constant voltage charging, gassing, sulphation, temperature, hydrometer, insulation and resistance (I/R) checks, and venting • Safety precautions to be taken when dealing with lead acid batteries • Neutralization of acid spills, action to take in the event of an acid spill and battery boil in an aircraft, cleaning, maintenance, storage and shipping requirements • Environmental hazards associated with lead acid batteries • Battery maintenance facilities, separation of location from nickel cadmium battery servicing area, ventilation, storage of acid and distilled water, mixing and dilution of sulphuric acid, protective clothing, battery service life and records of maintenance	**7.7.1. Introduction** • Information required by pilot and crew • Mandatory instruments • Classification of aircraft instruments by type • Classification of aircraft instruments by principles • Classification of aircraft instruments by function • Information presentation and dial design • Instrument panel configurations
7.6.2. Power supplies: Nickel cadmium batteries • Plate materials, insulators, electrolyte, casing,	**7.7.2. Atmospheric physics** • Understanding of the atmosphere, its layers and

terminals, capacity and capacity testing, determination of state of charge, gassing, venting, constant current charging and constant voltage charging, cell imbalance, cell voltage reversal, cell removal and replacement, cell leak testing, thermal runaway causes and prevention, temperature monitoring and warning, deep cycle recovery, and insulation and resistance (I/R) testing • Neutralization of electrolyte spills, cleaning, maintenance, storage and shipping requirements • Environmental hazards associated with nickel cadmium batteries • Battery maintenance facilities, separation of location from lead acid servicing area, ventilation, storage of potassium hydroxide, protective clothing, battery service life and records of maintenance	pressure, temperature and density variance with altitude • Methods for measuring atmospheric pressure • ICAO Standard atmosphere • Operation of aneroid and mercury barometers for measuring atmospheric pressure
7.6.3. DC generation • Operation and characteristics of separately excited, shunt, series, compound wound and permanent magnet generators • Generator construction: yoke, interpole and compensation windings, auxiliary interpoles, armature assembly, end frame assembly, brushes and gear assembly, terminal blocks, spark suppression, and installation • Residual magnetism and effects of "flashing the field" • Voltage regulation: carbon pile, vibrator type, cut-out, transistor type, solid state, and reverse current relays • Multi-generator distribution: load sharing/paralleling, system layouts, and interlock circuits • Starter generator systems, control, switching, and generator control units (GCU)	**7.7.3. Terminology and conversion** • Understanding of the following instrument terminology: • hysteresis error • parallax error • absolute, differential and gauge pressure • Methods of compensation of instrument mechanisms for temperature variations • Reasons for hermetically sealing instruments • Conversion from and to: • millimetres (mm) of mercury to inches of mercury, to millibars, to hectopascals, to pounds per square inch • knots to miles per hour • US gallons to imperial gallons to litres to pounds
7.6.4. AC generation • Cycle and frequency, instantaneous and amplitude values, root mean square values, phasing and phase relationships, and interconnection of phases • Generator power ratings, power factor, effective power, apparent power, and reactive component (KVAR) • Frequency wild generation systems: operation and application • Generator construction: rotor, stator, brushes and gear assembly, slip rings, cooling fan, casing and end frame • Constant frequency generation systems: operation and application (including brushless units) • Generator construction: rotor, stator, exciter shunt field and stabilizing windings permanent magnet, exciter main poles, cooling system, and temperature compensation • Constant speed drives (CSD): operation and construction, CSD and generator disconnect	**7.7.4. Pressure measuring devices** • Operation, function and construction of capsules (absolute and differential), diaphragms, bellows (absolute and differential) and bourdon

mechanisms • Integrated drive generators (IDG): construction and operation • Air driven generators (ADG) and ram air turbines (RAT): operation, function, and deployment • Multi-generator distribution • Load sharing and paralleling, real load sharing and reactive load sharing	
7.6.5. Auxiliary power units (APU) • Operation, control and protection of auxiliary power units • Function of power generation • Fire protection and warning	**7.7.5. Pitot static systems** • Operation and construction of pitot static probes and static vents (primary and alternate) • Layout of typical pitot static systems • Pressure (position) error and its effect on pitot static instruments • Pitot static system maintenance and leak testing

7.6.6. Power conversion equipment
• Rectifiers (conversion of AC into DC): selenium rectifiers, silicon rectifiers, operating limitations of rectifiers, silicon controlled rectifiers (SCR), rectifier circuit connections, and three-phase rectifiers
• Transformers: auto transformers, current transformers, potential/parallel transformers, control transformers, winding configuration star/delta, transformer ratings, and transformer rectifier units (TRU)
• Rotary conversion equipment: rotary converters, motor generators, rotary inverters and static inverters
• Frequency, voltage and current control
	7.7.6. Altimeters
	• Operation and construction of counter pointer altimeters including the effects that variation in temperature and atmospheric pressure have on their indications
	• Understanding of the "Q" code terms: QFE, QNE and QNH
	• Effect of QFE, QNE and QNH settings on the reading of an altimeter
	• Effects and conditions associated with altimeters:
	  • after effect
	  • scale error and barometric scale error
	  • friction
	• Altimeter testing procedures

7.6.7. Power distribution systems • Classification of power service requirements into vital, essential and non-essential • Operation and layout of split and parallel bus systems, load shedding systems, priority bus systems, emergency bus, battery bus and ground power bus • Defect analysis and fault finding • Wire and cable types: identification, uses, characteristics, screening, protection, pressure and moisture sealing, looms, conduit and ducting, and clamping • Bonding, earth/ground points, and DC/ACIRF earths • Plugs and connectors and associated insertion and removal tooling • Auxiliary power unit (APU) and ground power unit (GPU) interlocks and interface	**7.7.7. Vertical speed indicators (VSI)** • Operation and construction of vertical speed indicators, including instantaneous vertical speed indicators
7.6.8. Circuit protection devices • Fuses, fuse holders, current limiters, limiting resistors, circuit breakers, reverse current cut-out relay, reverse current circuit breaker, over voltage protection, under voltage protection, over frequency protection, under frequency protection, Merz-Price protection system, and power contactors	**7.7.8. Air speed indicators (ASI)** • Understanding of the following ASI-related terms: • indicated, calibrated and true air speed • speed of sound (subsonic, sonic, transonic and supersonic) • mach number and critical mach number • maximum operating speed/velocity (VMO) • maximum operating mach number (MMO)

	• Operation, function and construction of: ASI and switches, Machmeter, mach/ASI, maximum allowable indicators • ASI testing procedures
7.6.9. Circuit controlling devices • Switches, single and multi-pole/throw varieties • Toggle and tumbler switches, push switches, rocker-button switches, roller switches, micro-switches, time switches, rheostats, pressure switches, mercury switches, thermal switches, relays, proximity switches, attracted-core heavy duty relay, attracted-armature light duty relay, polarized armature relay, slugged relay, and magnetic amplifiers	**7.7.9. Miscellaneous altitude systems** • Operation, function and construction of typical altitude alerting and reporting systems, including encoding altimeters
7.6.10. DC motors and actuators • Operation and construction of DC motors and actuators • Characteristics and uses of shunt, series and compound motors (normal compound, stabilized shunt and shunt limited), and split field motors • Speed direction and travel control, regulation and position feedback • Clutches and brakes	**7.7.10. Servo altimeters and air data computers** • Operation, function and construction of servo altimeters • Principles of operation and layout of a typical air data computer system, including inputs and outputs • Signal processors: mechanical, electrical and electronic
7.6.11. AC motors and actuators • Operation and construction of AC motors and actuators • Methods of speed and rotational control: single-phase, two-phase and three-phase • Clutches and brakes	**7.7.11. Instrument pneumatic systems and direct reading gauges** • Operation, function, construction and layout of a typical aircraft instrument pneumatic system • Operation and construction of direct reading pressure, capillary type pressure and temperature gauges
7.6.12. Flight controls • Principles, operation and maintenance of power control units (PCU), flap motors protection and control, and trim motors • Position indication • Fly-by-wire flight control systems (both digital and analogue), full authority systems and manual reversion systems	**7.7.12. Temperature indicating systems** • Wheatstone bridge application to instrument indication • Operation and construction of various types of thermocouple • Measurement of static air temperature indicating systems and total air temperature • Cold junction compensation, material and construction of thermocouple leads and probes • Operation and construction of radiation pyrometer type temperature indicating system • Operation, construction and advantages of radiometer type indicators
7.6.13. Fuel systems • Fuel booster pump operation, control, construction and indication • Function and operation of electrically controlled fuel valves	**7.7.13. Fuel flow and fuel quantity indicating systems** • Principles, operation, function and layout of typical float, capacitance and electronics type fuel quantity indicating systems • Effects of temperature on fuel indicating system • System compensation, adjustment and power supplies • Principles, operation, function and location of typical fuel indicating system, including indicator, transmitter and power supplies

7.6.14. Hydraulic systems • Function, operation, location and construction of electric pumps (indication and control) • Function and operation of electrically controlled hydraulic valves	**7.7.14. DC synchronous systems and engine speed indicating system** • Operation and construction of DC desyn and selsyn systems • Operation, construction and maintenance of mechanical and electrical engine speed indicating systems and associated components

7.6.15. Pneumatic systems
• Operation of control indication and protection devices
• Function and operation of electrically controlled air valves
	7.7.15. Engine indicating systems
	• Operation, construction and maintenance of the following engine instruments:
	  • manifold pressure gauges
	  • torque meters
	  • exhaust gas temperature gauges
	  • engine pressure ratio gauges
	  • turbine inlet temperature gauges
	  • engine vibration systems
	  • AC inductor
	  • ratio meter oil pressure system
	• Understanding of terminology associated with engine indicating/data systems

7.6.16. Landing gear systems • Operation and function of electrical landing gear control and position indication • Air/ground sensor systems • Function and control of automatic braking systems • Function, testing and operation of electric anti-skid system (covering each situation: no skid, skid and landing)	**7.7.16. Gyroscopic principles** • Understanding of gyroscopic principles and terminology, including axis and plane of spin, degree of freedom, input and output axis, displacement gyro, topple and precession • Relationship of Newton's First Law of Motion to Gyroscopes • Gyroscopic precession and determination of the direction of precession resetting from applied forces • Apparent precession and calculation of earth rate • Rigidity and its affecting factors • Gimbal lock, gimbal layout for two and three gimbal gyroscopes • Drift (real and apparent) and affecting factors • Gyro types: free, rate, tied and earth • Precautions associated with the use and handling of gyroscopic instruments
7.6.17. Propeller and engine control systems • Function, operation, testing and maintenance of electrical propeller synchronizer and synchro-phaser systems • Function, operation and testing of electric propeller feathering systems • Function, operation and control of electronic engine control systems (both digital and analogue) including Full Authority Digital Engine Control (FADEC) • Function and operation of electrical engine temperature and speed limiting systems	**7.7.17. Artificial horizons (AH)** • Operation, function and construction of air- and electrically-driven AH • Understanding of the information displayed on AH • Errors, acceleration, turn and erection, and methods for overcoming them • Operation of the following erection systems: pendulous vane, ball type, torque motor and levelling switch • Operation and precautions associated with fast erect systems
7.6.18. Ignition systems (piston engines) • Safety precautions associated with aircraft ignition systems • Function, operation and testing of magneto ignition (high and low tension systems), magneto and	**7.7.18. Turn and bank and turn coordinators** • Operation, function and construction of air- and electrically-driven turn coordinators, and turn and bank indicators • Understanding of the information presented on

distribution speeds, "E" gap significance and adjustment, auxiliary starting devices, impulse couplings, compensating cams, ignition switches, dual ignition, and ignition leads	turn coordinators, and turn and bank indicators
7.6.19. Ignition systems (turbine engines) • Safety precautions associated with aircraft ignition systems • Operation and layout of high energy ignition units (HEIU) (both AC- and DC-powered) • High-energy igniter plugs: types, construction and maintenance	**7.7.19. Directional gyros (DG)** • Operation, function and construction of directional gyros • Operation and use of manual caging knobs • Effects of gimbal re-balancing and gimbal errors on instrument operation

7.6.20. Fire detection and extinguishing systems
• Construction, operation, layout, testing and trouble- shooting of the following fire detection systems:
  • thermal switch
  • continuous loop (fire wire)
  • continuous element or pressure type sensor responder
• Operation, construction, layout, testing and trouble-shooting of the electrical aspects of aircraft fire extinguisher systems
• Safety precautions to be observed when dealing with aircraft fire extinguisher systems (including handling of explosive cartridges)
• Construction and operation of the following smoke detection systems: carbon monoxide, photoelectric and visual
• Typical fire and smoke cockpit warning indications, lights, bells, annunciator panels, and audio warnings
	7.7.20. Compass systems
	• Understanding of the following in relation to terrestrial magnetism:
	  • true magnetic and geographic poles
	  • magnetic meridian
	  • variation or declination
	  • isogonal lines
	  • agonic lines
	  • magnetic equator
	  • angle of dip or magnetic inclination
	  • isoclinal lines
	  • aclinic lines or magnetic equator
	  • deviation
	  • isodynamic lines
	• Effects on compass readings of soft and hard iron magnetism
	• Methods used to overcome inherent errors and deficiencies in compass systems
	• Problems associated with navigation over polar regions
	• Understanding of the terms related to remote reading compasses: nutation, null, synchronized, slaved and free
	• Operation, function and layout of remote compass system, including remote sensors, flux detectors, power supplies and heading reference outputs
	• Modes of operation: slaved, free and directional gyros (DG)
	• System synchronization methods
	• Compass swinging: calculation of (from information obtained) and removal of errors in coefficients A, B and C
	• Calculation and completion of compass calibration card

7.6.21. Aircraft lighting • Operation, control layout and testing of typical aircraft lighting systems (both internal and external) • External lighting: navigation lights, anti-collision lights (rotating and flashing), strobe lights, landing and taxi lamps, ice inspection lights, area inspection lights and logo lights • Safety precautions when handling high-energy strobe light components	**7.7.21. Ground proximity warning systems (GPWS)** • Requirements for GPWS • Visual and aural indications for modes 1 to 5 (including sub-modes) • Inputs required for operation of a typical GPWS and aircraft system interface • Operation and function of typical GPWS • Interpretation of mode and sub-mode envelope graphs • Override and inhibit functions

• Internal lighting: cockpit area lighting, instrument panel lights, instrument integral lighting, flood lighting, electroluminescent lighting, passenger cabin lighting, passenger instructional lighting (no smoking and fasten seat belts), strip lighting and passenger service unit (PSU) lighting • Emergency lighting including crash inertia switches, floor proximity emergency escape path lighting and emergency exit lighting	
7.6.22. Ice and rain protection systems • Function of system control and overheat components • Windscreen heating: control, indication and failure • Windscreen wiper, washer and rain repellant systems • Engine, propeller and airframe anti-ice protection: thermal, pneumatic and electrical • Sensor ice protection: pitot head, static port, angle of airflow, and temperature probes • Waste water and toilet drain heaters • Antenna heaters • Overheat indications and protection • Ice warning and sensing devices indications	**7.7.22. Flight data and cockpit voice recording systems (FDR/CVR)** • System requirements, operation, protection and installation of FDR/CVR, including the following primary parameters: time, pressure altitude, vertical acceleration, magnetic heading, and press-to-transmit (radio transceiver)/event marker • Methods of recording information: trace recording and electromagnetic • Function of system components including signal conditioning units, entry and encoding panels • Interface with aircraft systems • Data recovery, analysis and verification

7.6.23. Air conditioning and heating systems
• Principles and operation of air conditioning
• Understanding of the following terms:
  • sensible heat
  • latent heat
  • conduction
  • convection
  • radiation
• Principles, operation, construction and maintenance of typical vapour cycle air conditioning systems
• Refrigerant types and uses, and physical and environmental hazards associated with each type
• Principles, operation, construction and maintenance of typical air cycle machines
• Control, monitoring, protection, maintenance and airflow of typical air conditioning systems
• Operation, construction and maintenance of typical combustion heater
• Heater warning and protection devices
	7.7.23. Electronic instrument and information display system
	• Display types: CRT, LED and LCD
	• Symbol generation and symbol generators
	• System operation, system layout and interpretation of information presented on the following:
	  • electronic centralized aircraft monitoring system (ECAM)
	  • engine indicating and crew alerting system (EICAS)
	  • flight management system (FMS)
	  • electronic horizontal situation indicator (EHSI)
	  • electronic attitude direction indicator (EADI)
	• Head-up displays and presentation
	• Moving map and flight tracking systems

7.6.24. Centralized warning and indication systems
• Operation of central warning and indication systems including inputs, output warnings and priority philosophy
	7.7.24 Vibration measurement
	• Sensing devices:
	  • signal conditioning and process
	  • display and indication
	  • alarm levels and warnings

7.6.25. Galley and toilet service systems • Operation, safety devices and control of service power: supplies, water heaters, ovens, toilets and associated systems and equipment	
7.6.26. Ground electrical power supplies • Understanding of the operation and control of typical ground supply equipment including:	

• DC battery carts; DC GPU; AC/DC GPU; rectifiers and inverters • Ground power supply plugs: types/patterns • Ground power and aircraft interface, interlocks and safety devices	
8.3. Automatic Flight Control System (AFCS): Fixed Wing:	**8.4. Automatic Flight Control System (AFCS): Rotary Wing:**

8.3.1. Fundamentals of AFCS
• Understanding of the following terms:
  • authority
  • single axis autopilot
  • wing leveller and auto-stabilizer
  • couple
  • engaged
  • capture
  • crosswind effect
  • gain
  • washout
  • cone of confusion
  • versine generation and application
• Operation and typical layout of a single axis (roll) AFCS
• Operation of moving vane and E and I bar sensors
• Understanding of inner loop stabilization and outer loop control
• Purpose, advantages and disadvantages of control signal limiting and gain adjustment
• Methods by which roll and roll/yaw error signals are sensed in rate, displacement and inclined rate gyros
• Operation and construction of duplex, electro-pneumatic, electro-mechanical and electro-hydraulic servo-motors
• Differences between series and parallel connected servo-motors
• Operation and methods of torque limiting
• Methods of achieving and factors affecting artificial feel
• Understanding of the basic operation of a fly-by-wire system of controlling an aircraft's control system
• Understanding of power-assisted and power-operated flight controls
	8.4.1. Fundamentals of AFCS
	• Understanding of the following terms and their interaction with each other:
	  • air density
	  • centrifugal force
	  • tip path plane
	  • coning angle
	  • lift thrust vector resultant
	  • pitch angle
	  • angle of attack
	  • collective pitch
	  • cyclic pitch
	  • blade loading
	  • relative airflow
	  • thrust or virtual axis
	  • axis of rotation or shaft axis
	  • feathering
	• Understanding of the relationship between: lift, thrust, weight, drag, and CG range
	• Understanding of the terms and the relationship between: vortex ring state, power settling, and over pitching
	• Torque reaction and its effect on directional control of helicopter
	• Gyroscopic precession and the use of this effect in providing control of the main rotor disc for forward, sideways and rearward flight
	• Dissymmetry of lift and its control
	• Understanding of corriolis effect and features (lead/lag hinges and underslung rotor) used to relieve stresses it creates
	• Ground effect and translational lift and their relationship
	• Translating tendency and its correction by mast offset and cyclic rigging
	• Understanding of the reason for blade tip stall and why it results in nose pitch up of the helicopter

8.3.2. Command signal processing/turbulence penetration
• Methods by which attitude changes are detected in roll, pitch and yaw
• Methods and purposes of achieving the following signal processes within an autopilot system:
  • synchronization
  • limiting
  • gain and adaptive control
• Operation and layout of control wheel steering
• Operation and function of trim indicators
	8.4.2. Rotary wing stability
	• Understanding of static and dynamic stability and why most helicopters are considered to be statically stable and dynamically unstable
	• Understanding of how the inherent dynamic instability is overcome by the use of the following design methods: stabilizer bar, offset flapping hinges and delta three hinges
	• Ground resonance and its causes, and remedial maintenance action to be taken should it occur

• Methods of reducing or eliminating the effects of turbulence on the operation of a flight control system	

8.3.3. Modes of operation: Roll channel
• Selection and the operation of the following modes:
  • basic stabilization
  • turn command
  • heading hold
• VHF omnidirectional radio range (VOR)/localizer (LOC)
	8.4.3. Roll and pitch control
	• Operation, function and layout of basic helicopter flight control system, particularly the operation of pitch and roll channels

8.3.4. Modes of operation: Pitch channel
• Selection and the operation of the following modes:
  • basic stabilization
  • pitch command
  • altitude hold
  • vertical speed
  • mach hold
• Operation and purpose of a mach trim system	

8.3.5. Yaw dampers • Operation and function of yaw damping systems • Interaction of a yaw damper with an autopilot (including autopilot interlocks) • Understanding of Dutch Roll phenomenon • Aileron and rudder control interaction during turns	**8.4.4. Helicopter yaw control and trim** • Operation, purpose and layout of the yaw channel • Function of yaw and gravity trim systems
8.3.6. Automatic trim control • Operation of automatic pitch trim systems • Operation and function of flap compensation systems • Operation and function of mach trim • Operation and function of alpha trim • Operation and function of centre of gravity (CG) trimmers	**8.4.5. System operation** • Operation of helicopter automatic flight control system when operating collective or power axis mode, coupled or instrument flight rules (IFR), and stability augmentation system (SAS)

8.3.7. Autopilot navigation aids interface
• Operation and function of the following navigation system inputs and their effects and interface with an autopilot:
  • VOR
  • LOC
  • glideslope systems (G/S)
  • Doppler
  • compass systems
  • inertial navigation
• Operation of crosswind compensation
	8.4.6. Autopilot and navigation aids interface
	• Operation and function of the following navigation system inputs, their effects and interface with the autopilot system: VOR, LOC, glideslope and marker and instrument landing system (ILS)

8.3.8. Flight director systems • Operation, function and construction of an altitude direction indicator (ADI) and a horizontal situation indicator (HSI) • Operation and layout of typical flight director systems operating in both coupled and uncoupled modes • Information display, both analogue (mechanical instruments) and electronic flight instrument system (EFIS)	**8.4.7. Flight director systems** • Operation, function and control of altitude direction indicator (ADI) and HSI • Operation and location of typical helicopter flight director system operating in both coupled and uncoupled modes • Information display, both analogue mechanical instruments and EFIS

8.3.9. Maintenance data Understanding of the use of maintenance data to Specifications 100 or 2100 of the Air Transport Association (ATA) of America	**8.4.8. Maintenance data** Understanding of the use of maintenance data to Specification 100 or 2100 of the Air Transport Association (ATA) of America
12.3 Basic Workshop & Maintenance Practices: Avionics — Electrical	**12.4 Basic Workshop & Maintenance Practices: Avionics — Instrument**
12.3.1. Lead acid batteries • Checking of battery condition, adjustment of specific gravity of electrolyte, battery charging practise; capacity, discharge and insulation tests; others • Overhaul procedures, including leak test of cells and cell replacement • Safety precautions	**12.4.1 Pressure indication** • Mechanically-operated gauges (e.g. Bourdon tube gauges): partial dismantling, examination, strip inspection, reassembly and calibration with dead weight c tester • Pressure transducers, electrically-operated transmitters, ratio metres, etc.: strip inspection, reassembly and calibration • Electrically-operated gauges: strip inspection, reassembly and calibration
12.3.2. Nickel cadmium batteries • Checking of battery condition: determining state of charge, cell balancing, charging, etc. • Checking of electrolyte level and insulation tests • Safety precautions • Cell replacement • Deep cycling of nickel cadmium units	**12.4.2 Flight instruments** • Calibration checks of flight instruments • Pitot heads and static vents: maintenance checks • Altimeters: dismantling, inspection, reassembly and calibration checks • Air speed indicators (ASI): dismantling, inspection, reassembly and calibration checks • Machmeters: dismantling, inspection, reassembly and calibration checks • Rate-of-climb indicators: dismantling, inspection, reassembly and calibration checks
12.3.3. Wire and cable work • Making up of wire lengths and specimen cable looms: soldering and crimping ends, identification of cables, using routing charts, and fitting plugs and sockets • Cable tracing practise: continuity and insulation checks on cable runs • Practice in aircraft wiring as carried out during modification or repair work: full tests of circuit	**12.4.3 Gyroscopic instruments** • Air-driven gyroscopic instruments: partial dismantling, examination and reassembly • Electrically-driven gyroscopic instruments: partial dismantling, examination and reassembly • Artificial horizon: dismantling, inspection and reassembly • Directional gyro: dismantling, inspection and reassembly • Turn and bank indicator: dismantling, inspection and reassembly • Zero reader: dismantling, inspection and reassembly • Calibration checks on gyroscope test turntable
12.3.4. Pressure indication • Mechanically-operated gauges (e.g. Bourdon tube gauges): partial dismantling, examination, strip inspection, reassembly and calibration with dead weight c tester • Pressure transducers, electrically-operated transmitters, ratio metres, etc.: strip inspection, reassembly and calibration • Electrically-operated gauges: strip inspection, reassembly and calibration • Bonding, continuity and insulation testing • Bonding checks: use of bonding tester • Continuity and insulation tests on aircraft circuit; use of Megger testers	**12.4.4 Engine speed indication (ESI)** • ESI generators (DC and AC types): partial dismantling, inspection and reassembly • ESI gauges: partial dismantling, inspection and reassembly • Engine speed synchronizing gear: examination and demonstration of principles • Generators and gauges: dismantling, inspection, reassembly and calibration checks

• Millivolt drop checks at cable joints and terminal ends	
12.3.5. Generators and electric motors • Dismantling, examination and reassembly • Demonstration of generator test	**12.4.5 Thermometers and temperature indication** • Engine temperature thermocouples: demonstration of cylinder head, jet-pipe temperature and other types • Radiometer temperature gauges: partial dismantling, examination and reassembly of transmitter and indicator units • Dismantling, reassembly and testing of temperature, and measuring instruments of various kinds • Tests on various kinds of temperature sensing units (e.g. fire and overheating detectors, cabin air duct stats, and inching controls for cooler shutters) • Use of portable test kits for checking gas turbine powerplant thermocouple installations
12.3.6. Voltage regulators, cut-outs and relays • Partial dismantling, followed by examination and reassembly, of carbon pile and other types of voltage regulators • Dismantling, examination and reassembly of accumulator cut-outs, reverse current relays, solenoids and relays from various circuits, and thermal circuit breakers	**12.4.6 Fuel contents indication** • Float-operated desynn contents gauges: examination and demonstration of operation dismantling, inspection, reassembly and test • Capacitance type contents gauges: examination and demonstration of operation reassembly and test • Flowmeters: dismantling, inspection, reassembly and test
12.3.7. Generators and alternators • Strip inspection: undercutting of commutators, checks for brush wear, brush spring loading and brush bedding • Testing of generator elements: armature testing, continuity tests on field coils, armature shaft alignment, and wear of ball races and housings • Reassembly and insulation test of generator • Testing of generators and alternators on test rig • Voltage regulators: overhaul procedure, correction of basic setting and adjustments making • Adjustment and rig testing of cut-outs and relays • Current balancing adjustments of DC power circuits on simulator of multi-engined aircraft electrical system • Electromagnetic relays: inspection and polishing of contacts, setting and adjustment, and millivolt drop tests on test rig • Constant speed drives (CSD): removal from alternator and testing • Integrated drive generator (IDG): dismantling, inspection, and overhaul	**12.4.7 Compass systems** • Magnetic compasses: friction and damping tests, practice compass swing, and compensation • Remote compass: examination and demonstration • Tests of compass swinging site • Swing of compass in available aircraft: compensation practice • Remote compass: partial dismantling, inspection, reassembly and test
12.3.8. Electric motors • Starter motors for piston and turbine aero engines: dismantling, examination for condition and wear, check for brush gear and commutator, check of clutches and geared drives; reassembly and test • Dismantling, inspection, reassembly and test of motors for fuel line pumps, hydraulics, propeller feathering, and windscreen wipers	**12.4.8 Miscellaneous instruments** • Examination and demonstration of other types of instruments (flowmeters, navigation and landing aid presentations)

• Linear and rotary actuators: dismantling, reassembly, and bench testing	
12.3.9. Inverters and converters • Rotary inverters and converters: dismantling and check for brushes and commutators, cleaning and testing of armature, and reassembly and adjustment • Testing: checking of input and output voltages; adjustment of frequency control • Static inverters and converters: inspection, adjustment and testing of output voltage and frequency	
12.3.10. Equipment • Magnetos: overhaul and test procedure for high and low tension systems • Spark/igniter plug testing, ignition lead testing and inspection, and booster coil testing • Engine high-energy ignition units: overhaul and test procedure • Safety precautions	
12.3.11. Electrical circuit equipment • Examination and partial overhaul of a wide range of miscellaneous electrical components such as transducers, magnetic amplifiers, rectifiers, transformers, Wheatstone bridge and other balancing devices, and sensing elements • Adherence of all testing in accordance with manufacturers' instructions • Dismantling (as appropriate), examination and reassembly of electrical components, including converters, inverters, switchgear, heating units, and actuators	
12.5 Basic Workshop & Maintenance Practices: Avionics — Autoflight	**12.6 Repair, Maintenance & Function Testing Of Aircraft Systems/Component: Avionics**
12.5.1. Autopilots • Examination and demonstration of autopilot mock-up and components	**12.6.1 Airborne and test equipment practice** • Use of representative airborne radio and radar equipment and practice in servicing, installation and overhaul according to procedures laid down in the manufacturers' approved manuals • Removal and replacement of equipment from aircraft racks, checks on power supplies, and remote controls • Routine maintenance inspections of equipment in situ • Operational checks • Bench tests, measurement of performance characteristics, tuning, adjusting, fault finding, aligning and repairing • Understanding and use of remote specialist communications, navigation and radio test equipment for both ramp and workshop • Understanding and use of system built-in test equipment (BITE), including comprehension of output data

	• Power supplies, installation and wiring, signal tracing, and use of cathode ray oscilloscope (CRO) • Audio amplifier, installation and wiring, fault tracing and rectification
12.5.2. Flight control systems • Autopilots (electrical or electronic): dismantling, examination of components, reassembly, and installation in aircraft or on simulator by following manufacturer's test programme; practise with portable test kit • Autopilots (pneumatic or hydraulic actuation): dismantling of component parts, reassembly, installation in aircraft or simulator, and function tests • Examination and testing of elements of flight director systems, automatic flare and automatic landing systems, as required	**12.6.2 Demonstration of test procedures on airborne equipment** a) Identification: identity and location of principal types of airborne communication and navigation equipment: racking systems, power supplies, antennae and other interconnections b) Demonstrations of bench tests on sample equipment, including use of screened rooms
	12.6.3 Wiring, cabling and soldering techniques • Wiring: practice in stripping insulation; splicing; wiring to lugs; terminals and tube sockets; and dismantling, soldering and reassembly of connectors • Cables: lacing of wires to form a cable, termination and soldering of cable ends, and serving of coaxial cables • Soldering: practice with different sizes of soldering irons, different grades of solder, fluxes and types of connectors • Micro-miniature precision soldering techniques • Handling of electrostatic sensitive devices
	12.6.4 Instrumentation • Multimeter: practice in measuring and calculating series and parallel resistance; voltage and current measurements on various circuits; others • Megger: continuity and insulation tests on aircraft cable assemblies structure; practice with circuit boards; others • Simple valve voltmeter • Frequency metres, absorption and heterodyne: practice in frequency measurement • "Q" metres: practice in measuring L, R, C and Q • Signal generators: demonstration of cathode ray oscilloscope; demonstration of use to examine wave- forms, wave envelopes, and DC measurements
	12.6.5 Antennae • External wire aerials: splicing, tensioning and making connections • Static dischargers: inspection, servicing and renewal procedures • Fibreglass and resin laminate aerial masts: maintenance and repair • External blade, rod and rail aerials: removal, maintenance and repair, and replacement • Suppressed aerials: care and maintenance,

	maintenance and repair of dielectric covers • DF loops: inspection, routine maintenance, ground calibration, and preparation of correction chart • Reflectors and directors: care and maintenance
12.7 Repair, Maintenance & Function Testing Of Aircraft Systems/Component: Avionics	**12.8 Job/Task Documentation & Control Practices**
12.7.1. Airborne and test equipment practice • Use of representative airborne radio and radar equipment and practice in servicing, installation and overhaul according to procedures laid down in the manufacturers' approved manuals • Removal and replacement of equipment from aircraft racks, checks on power supplies, and remote controls • Routine maintenance inspections of equipment in situ • Operational checks • Bench tests, measurement of performance characteristics, tuning, adjusting, fault finding, aligning and repairing • Understanding and use of remote specialist communications, navigation and radio test equipment for both ramp and workshop • Understanding and use of system built-in test equipment (BITE), including comprehension of output data • Power supplies, installation and wiring, signal tracing, and use of cathode ray oscilloscope (CRO) • Audio amplifier, installation and wiring, fault tracing and rectification	**12.8.1. Aircraft heavy maintenance check: Avionics** • Preparation for Heavy Maintenance Check: documentation (task/job cards), logbooks, defect records, modification instructions; selection and display of equipment; tools required • Selected heavy maintenance operations • Compliance to the aircraft maintenance manual and typical airline major check schedule for each job • Conclusion of Heavy Maintenance Check: replacement of components; function tests; preparation for flight test; completion of documentation
	12.8.2. Aircraft repair or modification: Avionics • Selection of repair scheme or modification: damage to be studied and related to approved repair scheme as shown on manufacturers' drawings • Selection of material (to be checked for compliance with specification) • Embodiment of repairs according to prepared drawings or manufacturers' manuals • Testing to destruction of selected repair specimens to demonstrate strength of repair • Experience in workshop processes as applicable to testing, repair and reconditioning of aircraft parts • Acceptance tests and final inspection • Completion of documentation