Civil Aviation Safety Authority
of Papua New Guinea

Advisory Circular
AC66-2.3

Aircraft Maintenance Engineer Licence -Examination Subject 3 Aircraft Materials

Issue1
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GENERAL

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

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

PURPOSE

This Advisory Circular provides AMC for the syllabus content in respect of written examinations for Subject 3. (Aircraft Materials).

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

RELATED CAR

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

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

CHANGE NOTICE

This AC, replaces the Original AC dated 01 June 2015.

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Rule 66.57 Eligibility Requirements

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

The written examinations acceptable to the Director for Subject 3 (Aircraft Materials) should comply with the syllabus contained in this Advisory Circular. Each examination will cover all topics and may sample any of the sub-topics.

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

EXAMINATION OVERVIEW – SUBJECT 3

Subject 3 (Aircraft Materials) is closed book, written examination. The pass mark is 75 percent.

Application to sit an examination may be made directly online to ASPEQ. Refer to CASA Website https://casapng.gov.pg/personnel-licensing/Examinations-and-Testing/ for examination information.

An AME sample question booklet with 15 representative questions pertaining to this subject is available for purchase from ASPEQ.

General Examining Objective

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

Knowledge Levels

LEVEL 1: A familiarisation with the principal elements of the subject. Objectives: The applicant should:

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

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

An ability to apply the knowledge.

Objectives: The applicant should:

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

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

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

Objectives: The applicant should:

1. know the theory of the subject and the interrelationships with other subjects.
2. be able to give a detailed description of the subject using theoretical fundamentals and

specific examples.

3. understand and be able to use mathematical formulae related to the subject.
4. be able to read, understand and prepare sketches, simple drawings and schematics describing the subject.
5. be able to apply his/her knowledge in a practical manner using manufacturer's instructions.

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	A & P Technician General Textbook	Jeppesen	0-88487-203-3
2	A & P Technician Airframe Textbook	Jeppesen	0-88487-205-1
3	Welding Guidelines with Aircraft Supplement	Jeppesen	0-89100-076-3
4	Advanced Composites	Jeppesen	0-89100-358-4
5	Non-Destructive Testing for Aircraft	Jeppesen	0-89100-415-7
6	Aircraft Corrosion Control	Jeppesen	0-89100-111-5
7	Aviation Maintenance Technicians Series – General	Dale Crane	1-56027-422-0
8	Aviation Maintenance Technicians Series, Airframe - Volumes 1 Structures & 2 Systems	Dale Crane	1-56027-339-9 1-56027-340-2
9	FAA AC43.13-B: Acceptable Methods, Techniques and Practices Aircraft Inspection and Repair. See: FAA website	FAA	0-89100-306-1
10	Fundamentals of Aircraft Material Factors	Jeppesen	0-89100-340-1
11	Dictionary of Aeronautical Terms	Dale Crane	1-56027-287-2
12	Aviation Mechanics Handbook	Dale Crane	1-56027-412-3

Syllabus Layout

Topic Numbering – left hand column

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

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

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

Objective description – middle column

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

Knowledge levels – right hand column

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

Syllabus -Subject 3 (Aircraft Materials)

1. Metals and Metal Alloys

1	Metals and Metal Alloys	
1.1	**Steel - Terminology**	
1.1.1	*Study Ref. 1 & 7* Describe the following terms, conditions, characteristics and factors in respect of steels and steel alloys and give typical examples of where each may be used in aircraft construction or maintenance: a. Alloying agents b. Austenite c. Austenitic d. Cementite e. Ferrite f. Ferritic g. Gamma Iron h. High, medium and low carbon steels i. Martensite j. Martensitic k. Pearlite l. Pig iron	1
1.1.2	Using heat-treatment diagrams, describe how the desired grain structures are obtained during the steel manufacturing process.	1
1.2	**Stainless Steels**	
1.2.1	*Study Ref. 1 & 7* Describe the purpose, composition, uses and cold-working properties of stainless steels including: a. austenitic stainless steel. b. ferritic stainless steel. c. martensitic stainless steel. d. 18-8 stainless steel.	1
1.3	**Steel Alloying Agents**	
1.3.1	*Study Ref. 1 & 7* Describe the properties and characteristics of steels having the following alloying agents: a. Carbon (low, medium and high carbon steels) b. Silicon c. Phosphorus d. Nickel e. Chromium and chrome-molybdenum f. Nickel/Chromium g. Molybdenum h. Vanadium i. Tungsten	1
1.3.2	State the approximate percentage of the above alloying agents to achieve the desired properties of the steel.	1
1.3.3	Specify where each steel alloy could be used in aircraft or aircraft component construction.	1

1.4 1.4.1	**Steel Manufacturing Processes** *Study Ref. 1 & 7* Describe the following factors relating to the manufacture of steel: a. Manufacturing processes for pig iron, cast iron and steel b. Treatment of impurities including slag c. Importance of fluxes d. Adverse effects of sulphur	 1
1.5 1.5.1	**Non-Ferrous Metals** *Study Ref. 1 & 7* Describe the characteristics, properties, compositions and uses of the following non-ferrous metals and metal alloys as used in the construction of aircraft or aircraft components: a. Pure aluminium b. Clad aluminium c. Magnesium and Dow metal alloys d. Titanium (Alpha, Alpha-beta, Beta) e. Nickel, monel, K-monel and inconel f. Copper, brass, bronze, lead g. Aluminium bronze h. Muntz metal i. Beryllium copper (including the effects of using nickel as an alloying agent) j. Copper tubing k. Solder and silver solder l. Tin m. Zinc	 2
1.5.2	Describe the cladding process and precautions when using, storing, handling and identifying ALCLAD	2
1.5.3	Identify the relative disadvantages of titanium when subjected to very high temperatures.	1
1.6 1.6.1	**Aluminium Alloying Metals** *Study Ref. 1 & 7* Specify the effects of the following metals when alloyed with aluminium: a. Copper b. Manganese c. Silicon d. Magnesium e. Magnesium and Silicon f. Zinc	 1
1.6.2	State the approximate percentages of the above alloying agents needed to achieve the desired properties in the material for aeronautical use.	1
1.6.3	State the four digit numbering series for aluminium alloys: a. Copper - 2000 series b. Manganese – 3000 series c. Silicon – 4000 series d. Magnesium – 5000 series e. Magnesium and Silicon – 6000 series f. Zinc – 7000 series	2
1.7 1.7.1	**Magnesium Alloys** *Study Ref. 1 & 7* Identify the metals that are commonly alloyed with magnesium for aircraft use.	 1

1.7.2	Describe the limitations on the use of magnesium in aircraft construction, with particular regard to corrosion, cracking, burning and machining.	2
1.7.3	Identify the advantages of magnesium over other metals for aircraft use.	1

2. Testing of Materials

2	Testing of Materials	
2.1	**Testing Terminology** *Study Ref. 10*	
2.1.1	Explain tensile and compression testing of metals with particular regard to determining by calculation: a. ultimate tensile stress b. yield point c. percentage elongation d. Young's modulus of elasticity	2
2.1.2	From given data, calculate the tensile strength of a material under test.	2
2.2	**Hardness Testing** *Study Ref. 1,7 & 9*	
2.2.1	Explain the following testing methods used to determine hardness of metals: a. Rockwell b. Brinell	2
2.2.2	Describe the features, procedures, precautions, general principles, practices and applications relating to the use of the above hardness testers.	2
2.2.3	State the shape of the point used to contact the test specimen in each tester.	1
2.2.4	Describe how a Brinell hardness number is derived and give typical notations for hard and soft materials.	2
2.2.5	Identify on the Rockwell scale the notation for a hard and soft material and how the Rockwell number is determined for a specimen under test.	2
2.2.6	Specify precautions and limitations associated with testing thin gauge, narrow strips of material.	2
2.3	**Strength Versus Hardness** *Study Ref. 1 & 7*	
2.3.1	Describe the relationship of tensile strength to hardness of steels and the testing limitations relating to very hard and very soft steels.	2
2.4	**Steel Testing Methods** *Study Ref. 10*	
2.4.1	Outline the steel testing methods for tensile and compression strength, fatigue strength and impact resistance with particular emphasis on the following: a. Equipment used b. Testing procedures c. Specimen design d. Interpretation of data and specifications e. Application of test results to aircraft construction and maintenance	1
2.5	**Testing of Non-ferrous Materials** *Study Ref. 10*	
2.5.1	Describe the testing of aluminium to distinguish between annealed, cold-worked, heat-treated and aged material.	2

2.5.2	Describe the testing of non-ferrous materials for hardness, tensile strength, fatigue strength and impact resistance and electrical/magnetic properties.	2

3.Common Properties of Materials

3	Common Properties of Metals	
3.1	**Terminology Relating to Aircraft Materials**	
	Study Ref. 1 & 7	
3.1.1	Define the following terms that relate to the characteristics and properties of metals used in aircraft or aircraft component construction: a. Hardness b. Malleability c. Ductility d. Elasticity e. Toughness f. Density g. Brittleness h. Fusibility i. Conductivity j. Contraction k. Thermal expansion l. Electrical and magnetic properties m. Metal Cladding n. Typical melting points	1
3.1.2	Show examples of where the above properties may be found in aircraft metals.	1

4.Factors Affecting the Selection of Aircraft Materials

4	Factors Affecting the Selection of Aircraft Materials	
4.1	**Properties of Aircraft Materials** *Study Ref. 1 & 7*	
4.1.1	Define the following terms relating to the properties and characteristics of aircraft materials and give examples of where each is a factor in aircraft design, construction and maintenance: a. Strength b. Strength to weight ratio c. Compression strength d. Tensile strength e. Yield strength f. Shear strength g. Bearing strength h. Fatigue strength i. Metal stresses including tension, compression, shear, bending and torsion j. Failure modes k. Corrosion resistance	2
4.1.2	Where appropriate, from aircraft or component manufacturer's specifications, identify values relating to the above terms.	1

5.Heat Treatment of Aircraft Ferrous and Non-Ferrous Alloys

5	Heat-Treatment of Aircraft Ferrous & Non Ferrous Alloys	
5.1	**Steel** *Study Ref. 1 & 7*	
5.1.1	Explain the following processes, advantages and characteristics relating to the heat-treatment of steel: a. Hardening b. Hardening precautions c. Tempering d. Annealing e. Normalising f. Case hardening by nitriding or carburising g. Parkerizing h. Behaviour of steel during heating and cooling i. Heating and soaking j. Protective atmospheres k. Quenching and cooling l. The effects of using different quenching mediums during heat-treatment m. Temperature measurement and control n. Determining steel temperature using indicating devices and colour of the heated metal	2
5.1.2	Describe how the heat treatment process changes the grain structure of steels.	1
5.1.3	Describe what is meant by upper and lower critical points and the relevance these points have on the various heat treatment processes for steel.	2
5.1.4	State the general purpose of heat-treating metals.	1
5.2	**Non-Ferrous Metals** *Study Ref. 1 & 7.*	
5.2.1	State the methods used and the reasons for the heat-treatment of aluminium alloys, magnesium alloys and titanium.	2
5.2.2	Explain the limitations on heat-treating clad aluminium. (ALCLAD)	2
5.2.3	Identify light alloys that may be repeatedly heat-treated without adverse effects.	2
5.2.4	Describe the effects of heat-treating a pure metal.	1
5.3	**Treatment Processes for Non Ferrous Alloys** *Study Ref. 1 & 7*	

5.3.1	Describe the purpose, advantages and disadvantages of the following processes relating to non-ferrous alloys and how each process is carried out: a. Hardening b. Hardening of non heat-treatable aluminium alloys (cold-working or work-hardening) c. Heat-treatable alloys; solution heat-treatment requirements d. Toughening e. Strain and age-hardening f. Artificial aging g. Softening h. Solution Heat-treatment; temperature, time at temperature, quenching, cold water quenching, hot water quenching, spray quenching, lag between soaking and quenching, re heat-treatment, and straightening after solution heat-treatment i. Precipitation heat-treatment practices j. Annealing of aluminium alloys k. Chilling of certain types of rivet after heat treatment l. Heat-treatment of aluminium alloy rivets m. Heat-treatment of magnesium alloys including solution heat-treatment and precipitation heat-treatment n. How fire is prevented in a furnace during the heat treatment of magnesium alloys o. Heat-treatment of titanium alloys; purpose, stress relieving, full annealing, thermal hardening and case hardening p. How scale is removed from heat treated titanium alloys q. Heat treatment of monel metal components r. Natural aging of magnesium	2
5.3.2	Identify the problems that can occur in metal components if the correct heat treatment processes and procedures are not used.	2
5.4	**Heat-Treatment Equipment** *Study Ref. 1 & 7*	
5.4.1	Specify the heat-treatment equipment used for ferrous and non-ferrous metals, including furnaces, salt baths, quenching mediums, soaking, cooling, quenching apparatus and protective equipment.	1
5.4.2	Describe how the temperature of a furnace or bath is measured and controlled during heat treatment of materials.	1
5.4.3	State the principles of operation of a pyrometer.	1
5.4.4	Describe how sheet metals are commonly quenched.	2
5.4.5	Describe special requirements for the quenching of irregularly shaped objects.	2

6.Metal Working Processes

6	**Metal Working Processes**	
6.1	**Description of Metal Working Processes**	
	Study Ref. 1 & 7	
6.1.1	Outline the following metal working processes and give examples of where each process could be used in the manufacture of aircraft materials or components: a. Hot-working b. Cold-working c. Extruding d. Casting (permanent mould and die casting) e. Forging f. Drawing	1
6.1.2	Specify precautions and limitations relating to each process.	1
6.2	**Metal Cutting**	
	Study Ref. 1 & 7	
6.2.1	Describe how the following materials may be cut. Specify machines used, special techniques and precautions: a. Various thickness of steel plate b. Various sizes of round stock c. Aluminium and magnesium sheet d. Various sizes of metal tubing	1

7.Identification of Aircraft Materials

7	Identification of Materials	
7.1	**Classification of Steels** *Study Ref. 1 & 7*	
7.1.1	State the SAE four-digit classification for the following alloy steels: a. Carbon b. Plain carbon c. Free cutting d. Manganese e. Nickel f. Nickel chromium g. Molybdenum h. Chrome molybdenum i. Nickel ,chrome, molybdenum j. Chromium k. Chrome vanadium l. Silicon manganese	2
7.1.2	Describe what each digit of the code represents.	2
7.1.3	Identify what the classification “SAE” stands for and why it is used in the aeronautical industry.	1
7.2	**Identification of Aluminium and Aluminium Alloys** *Study Ref. 1 & 7*	
7.2.1	Compare the difference between wrought and cast aluminium and state where each process may be used.	1
7.2.2	Compare the differences between heat treatable and non-heat treatable aluminium alloy and state where each may be used on aircraft.	2
7.2.3	State the four digit code used to identify aluminium and its alloys including: a. major alloying element b. control of impurities c. percentage of pure aluminium	2
7.2.4	Identify the aluminium alloys most commonly found in the construction of both light aircraft and modern jets.	2
7.2.5	Using the four-digit code, identify pure aluminium and aluminium alloys with the following alloying agents: a. Copper b. Manganese c. Silicon d. Magnesium e. Magnesium and silicon f. Zinc	3
7.2.6	Describe the effects on the parent metal that the above alloying materials normally have and where each is desirable in the manufacture of aircraft structure or components.	2
7.2.7	Explain the correct means of identification marking aluminium alloy sheets.	3
7.2.8	Describe how sodium hydroxide (caustic soda) may be used to identify certain aluminium alloy sheets.	1

7.2.9	Identify the four-digit code for aluminium alloys that are deemed to be weldable.	2
7.3	**Heat-Treatment Identification**	
	Study Ref. 1 & 7	
7.3.1	Identify what is indicated by the following hardness conditions relating to aluminium alloys T, T1, T2, T3, T4, T5, T6, T7, T8, T9, T10 and –W.	2
7.3.2	Describe the process metals with each of these codes would have undergone to achieve the desired state.	2
7.3.3	Describe the identification of strain hardness or temper of aluminium alloys, such as-F, -O, -H, -H1, -H2, -H3.	2
7.3.4	State how the degree of strain hardening is indicated with regard to tensile strength, e.g. H32, H34, H36, H38 and H39.	2
7.3.5	Describe the processes aluminium with the above heat treatment codes would have undergone to achieve the designated state.	2
7.3.6	Explain the identification of clad aluminium and state what the cladding and core material may be composed of.	3
7.3.7	Identify common aircraft metals by their physical characteristics.	2
7.3.8	Specify how a heat treatable aluminium alloy may be identified using a physical test.	2
7.3.9	Explain the meaning of the temper designation (-W) when indicating the material condition.	3
7.4	**Heat-Treatment of Magnesium Alloys**	
	Study Ref. 1 & 7	
7.4.1	Describe the heat-treatment processes relating to magnesium and its alloys including; F, O, H24, T4, T5, and T6.	2
7.5	**Identification of Magnesium Alloys**	
	Study Ref. 1	
7.5.1	Describe the identification of Magnesium and magnesium alloys such as; F, O, H24, T4, T5 and T6.	2
7.6	**Titanium**	
	Study Ref. 1 & 7	
7.6.1	Describe the identification, composition and characteristics of titanium and titanium alloys in the following (A, B, C) classifications. Alpha, alpha-beta, beta, beta heat-treated.	2
7.6.2	Identify a test to identify titanium sheet.	1
7.6.3	Identify where titanium would most likely be used in the construction of modern aircraft or aircraft components.	1
7.7	**Substitution of Materials**	
	Study Ref. 1 & 7	
7.7.1	Identify principles, practices and requirements relating to the substitution of aircraft metals during the design of repair schemes or modification.	2

7.8	**Selection of Materials in Aircraft Construction** *Study Ref. 2 & 8*	
7.8.1	Describe the types and prime characteristics of materials used in the following aircraft applications: a. Aircraft structure including, skin, spars, stringers, bulkheads, formers and abrasion strips b. Control surfaces and balance weights c. Firewalls d. Undercarriage oleos, spring legs, skids and axles e. Undercarriage attachment fittings f. Engine mounts and bearing frames, g. Aircraft hardware including bolts, nuts, pins, washers, and rivets h. Bearings, gears, gear casings and bushes i. Springs, capsules, diaphragms j. Fairings, pulleys, pipes, hoses, control cables k. Electrical wiring including the advantages of aluminium over copper and vice versa l. Gas turbine engine; turbine blades, compressor blades, combustion chambers, tail pipes, casings and housings m. Piston engine crankcases, crankshafts, conrods, pistons cylinder heads, barrels, accessory gearboxes, mounting frames, exhaust systems, turbochargers, propellers and helicopter rotors n. Panels and work decks o. Fuel tanks and fuel cells p. Windows and windscreens q. Radomes, and antennae	1

8.Identification of Defects in Materials

8	Identification of Defects in Materials	
8.1	**Common Defects**	
	Study Ref 10 & 11.	
8.1.1	Identify causes and give examples of the following defects or failures associated with the operation of aircraft or aircraft components: a. Tensile failure b. Compression failure c. Shear failure d. Torsional failure and torsional/tensile failure e. Brinelling f. Galling g. Spalling h. Fretting i. Burnishing j. Overheating k. Overloading l. Incorrect heat treatment m. Lack of lubrication n. Weld decay o. Hydrogen embrittlement. p. Fatigue stress and fatigue failure q. Erosion of rotating componentry (e.g. propeller, turbine and compressor blades) r. Inclusions	2
8.1.2	Specify typical measures that are commonly taken to prevent the above failures.	1
8.1.3	Describe typical surface marks and indications identifying the types of failure listed above.	2
8.1.4	Determine the stresses associated with the fastening or operation of aircraft hardware and components, such as: a. bolts b. nuts c. studs d. rivets e. pins f. shafts g. discs h. blades i. connecting rods j. gears k. struts	3
8.2	**Identification of Failure Debris**	
8.2.1	Describe failure debris commonly found in filters or on magnetic plugs fitted to piston and gas turbine engines and gearboxes, and rotorcraft transmissions and gearboxes.	2
8.2.2	Specify debris test/identification methods.	2
8.2.3	Describe typical gear and bearing failures.	2
8.2.4	State the purpose of SOAP sampling programmes and interpretation of SOAP sample results.	1

9.Corrosion

9	Corrosion	
9.1	**Corrosion Chemistry** *Study Ref 1, 7 & 11*	
9.1.1	Describe the chemistry behind the various forms of corrosion found on aircraft.	2
9.1.2	Identify what substances metals are converted into during the corrosion process.	2
9.1.3	Identify common aircraft metals in order of their electrical potential. Show how anodes and cathodes develop and produce electron flow.	1
9.1.4	Describe the susceptibility of various aircraft materials to the common types of corrosion.	2
9.1.5	Specify why pure aluminium is considered to be corrosion resistant.	2
9.2	**Classification of Corrosion** *Study Ref 1, 7 & 11*	
9.2.1	Describe the two general classifications of corrosion: a. Direct chemical attack b. Electrochemical attack	2
9.3	**Corrosive Agents** *Study Ref. 1*	
9.3.1	Specify the effects of the following corrosive agents on aircraft structure. a. Acids and alkalis b. Salts c. Salt spray d. Air (moisture, humidity, acid rain, volcanic fallout) e. Organic growths	2
9.4	**Types of Corrosion** *Study Ref 1, 7 & 11*	
9.4.1	Describe the following types of corrosion, the causal factors, how each affects the base metal, and how each type of corrosion is treated or neutralised: a. Oxidation (ferrous oxide) b. Uniform surface corrosion c. Pitting corrosion d. Galvanic corrosion or dissimilar metal corrosion e. Concentration cell corrosion f. Oxygen concentration cell corrosion g. Metal ion concentration cell corrosion h. Active-passive cells i. Filiform corrosion j. Intergranular corrosion and intergranular stress corrosion k. Exfoliation corrosion l. Stress corrosion m. Corrosion fatigue n. Fretting corrosion	3

9.4.2	Describe the general identifying characteristics of corrosion on the following metals: a. Steel b. Copper c. Aluminium d. Brass e. Magnesium f. Titanium g. Lead	2
9.5 9.5.1	**Contributory Factors** *Study Ref 1, 7 & 11* State how the following factors contribute to corrosion: a. Size and type of metal b. Foreign materials c. Fluids and abrasives d. Electrical potential difference e. Lack of cleanliness f. Stress	 1
9.6 9.6.1	**Corrosion Detection** *Study Ref 1, 7 & 11* Detail corrosion detection methods and explain how results may be interpreted.	 3
9.7 9.7.1	**Corrosion Prone Areas on Aircraft** *Study Ref 1, 7 & 11* Describe the following corrosion prone areas, the likely types of corrosion found in these areas, and the probable causes: a. Engine exhaust trail areas b. Battery compartments and vents c. Lavatories and food service areas d. Wheel wells and landing gear e. External skin areas f. Engine inlet and frontal areas g. Cooling air vents h. Fuel tanks i. Piano wire hinges j. Control surface recesses: wing flap and spoiler recesses k. Flap tracks l. Bilge areas and water entrapment areas m. Landing gear boxes n. Engine mount structure o. Cylinder fins, crankcases and accessory housings p. Helicopter rotor heads, blades and gearboxes q. Control cables r. Welded areas s. Electronic equipment	 2
9.8 9.8.1	**Corrosion Effects on Specific Materials** *Study Ref 1, 7 & 11* Describe specific corrosion problems relating to: a. ferrous metal components. b. aluminium and aluminium alloys. c. magnesium. d. copper. e. titanium and titanium alloys.	 2

9.9	**Anti-Corrosion Treatments** *Study Ref 1, 7 & 11*	
9.9.1	Explain the following treatments relating to aluminium alloys: a. Mechanical corrosion removal b. Chemical neutralisation c. Cladding d. Surface oxide film; anodising e. Alodine solution f. Organic films including; zinc chromate, chromic acid etch, wash primer and epoxy primers g. Protection of integral fuel tanks for microbiological corrosion h. Shot-peening	3
9.9.2	Explain the following treatments for ferrous metals: a. Mechanical corrosion removal b. Abrasive blasting c. Corrosion removal from highly stressed parts d. Nickel or chrome plating e. Hard chroming f. Cadmium plating g. Sacrificial corrosion h. Galvanising i. Metal spraying j. Organic coatings k. Zinc chromate priming l. Sherardising m. Parkerising n. Enamels o. Chlorinated rubber compounds	3
9.9.3	Describe the following treatments for Magnesium alloys: a. Mechanical removal of corrosion b. Decarbonisation c. Surface treatments d. Anodising e. Chromic acid pickling f. Dichromate conversion g. Stannate immersion	1
9.9.4	Specify acceptable methods of anti corrosion treatment applied after the in-service repair or restoration of aircraft structure or components, with particular regard to: a. steel parts. b. painted surfaces. c. anodised parts. d. magnesium parts. e. aluminium parts. f. plated parts.	2
9.10	**Specific Corrosion Prevention Methods** *Study Ref 1, 7 & 11*	
9.10.1	Describe corrosion prevention methods such as: a. dissimilar metal insulation. b. powerplant external preservation. c. protection of light alloys from steel fasteners.	2
9.10.2	Specify the effects of improper heat-treatment on the corrosion of base metals.	2

9.10.3	Describe preventive maintenance methods to avoid corrosion.	2
9.10.4	Describe corrosion prevention and treatment methods for bonded metal honeycomb structure including the prevention of corrosion around rivets.	2
9.10.5	Specify the precautions when assembling graphite structure or panels containing light alloy hardware and fittings.	1
9.10.6	Describe corrosion proofing methods for seaplanes.	2
9.10.7	Outline common corrosion proofing methods employed during aircraft construction or fabrication.	1
9.10.8	Describe surface restoration methods for damaged protective films.	2
9.10.9	Describe procedures for handling aircraft recovered from salt water.	2
9.10.10	Describe the treatment of structure after electrolyte spills from the various types of aircraft battery commonly found in service.	2
9.10.11	State how titanium alloy is protected after light corrosion removal.	1
9.10.12	State how corrosion-resistant steel parts in exhaust systems should be blast cleaned.	1
9.10.13	Specify how the internal surface of steel tubing is best protected from corrosion.	2
9.10.14	Describe the process of internal engine inhibiting and why the crankshaft should not be turned after the final internal spray.	1
9.11	**Corrosion Repair Techniques and Limits** *Study Ref 1, 7 & 11*	
9.11.1	Describe corrosion repair techniques and repair limits.	2
9.11.2	From given information, determine component serviceable after repair or rework, to remove or treat corrosion.	2
9.12	**Mercury Contamination** *Study Ref 1 & 7*	
9.12.1	Specify the effects of mercury contamination on aircraft structure, methods used to remove the contamination and precautions to be observed.	2

10. Non-Destructive Testing

10	Non-Destructive Testing	
10.1	**Common Non-Destructive Testing Methods** *Study Ref. 5*	
10.1.1	Identify the six common non-destructive testing methods and describe their applications for aircraft.	1
10.1.2	Compare the advantages, disadvantages and limitations of each method.	1
10.1.3	Distinguish between false indications and defect indications for each of the NDT processes.	1
10.1.4	Describe common defects and how they would show up in each of the testing methods.	1
10.2	**Visual Inspection**	
10.2.1	Describe how various components may be inspected internally and externally using a magnifying glass, borescope or the naked eye.	2
10.2.2	Using sound technical reasoning, identify crack prone areas on aircraft and aircraft components.	2
10.3	**Liquid Penetrant Testing** *Study Ref. 5*	
10.3.1	Explain the following terms and activities relating to liquid penetrant testing procedures: a. Surface preparation, pre cleaning and removal of protective coatings b. Testing theory c. Penetrant application d. Excess penetrant removal e. Developer application f. Black light operation and its advantages g. Inspection area h. Indications i. Post inspection cleaning j. Factors affecting the success of liquid penetrant inspection k. System monitoring l. Health and safety considerations	2
10.4	**Magnetic Particle Testing** *Study Ref. 5*	
10.4.1	Explain the following terms and activities relating to magnetic particle testing: a. Magnetism of materials b. Testing theory c. Surface preparation including removal of protective coatings and plating d. Magnetisation e. Particle application f. Techniques for checking longitudinal and circumferential cracks g. Inspection techniques h. Identification of sub-surface inclusions i. Demagnetisation techniques j. Post test cleaning k. Factors affecting the magnetic particle test l. Monitoring the testing system m. Health and safety precautions	1

10.4.2	Give examples of components commonly tested by the magnetic particle process.	1
10.5	**Eddy Current Testing** *Study Ref. 5*	
10.5.1	Outline the following terms and activities relating to eddy current testing: a. Testing theory b. Impedance c. Frequency d. Eddy current instruments e. Test coils including small and large diameter coils f. Speciality probes g. Conductivity standards h. Thinning standards i. Crack standards j. Impedance plane analysis including lift-off, conductivity, permeability, effects of lift-off, material thickness, cracks, and magnetic-optic/eddy current imager k. Factors which determine the current value through the probe coil	1
10.5.2	Give examples of components or structure commonly tested by the eddy current process.	1
10.6	**Ultra-Sonic Testing** *Study Ref. 5*	
10.6.1	Outline the following terms and activities relating to ultrasonic testing: a. Testing theory b. Wave forms c. Sound wave generation d. Generation of longitudinal, shear, surface and plate waves e. Energy losses including reflection of ultrasonicwaves, attenuation and couplants f. Principles of operation including pulse-echo angle beam, through-transmission testing and immersion testing g. Factors affecting ultrasonic tests including sound beam characteristics and frequency h. CRT Display presentations including A-scan, B-scan and C-scan i. The use of reference standards	1
10.6.2	Give examples of components or structure commonly tested by the ultra sonic process.	1
10.7	**Radiographic Testing** *Study Ref. 5*	
10.7.1	Outline the following terms and activities relating to radiographic inspection: a. Principles of radiography b. Radiation sources including X-rays and gamma rays c. Radiographic equipment d. Steps to radiographic inspection including aircraft preparation, set-up, exposure, film processing and radiographic interpretation e. Health and safety requirements including the protection of persons not directly involved with the process	1
10.7.2	Describe how cracks, corrosion and other defects are identified on x-ray film.	1
10.7.3	Give examples of components or structure commonly tested by the x-ray process.	1

11.Aircraft Welding

11	Aircraft Welding	
11.1	**Various Welding Processes**	
	Study Ref. 3	
11.1.1	Describe the following welding processes and give examples of where each process would most likely be used: a. Gas tungsten arc (GTAW) or (TIG) b. Gas metal arc welding (GMAW) or (MIG) c. Oxyacetylenewelding (conventional gas welding) d. Electric arc welding e. Electrical resistance welding f. Electron beam welding g. Plasma arc welding h. Thermal spraying i. Laser welding	2
11.1.2	Describe the special processes, equipment, precautions, limitations and techniques associated with welding the following materials: a. Aluminium alloy b. Magnesium c. Titanium d. Copper alloys e. Stainless steel f. Sheet metals g. Castings	2
11.1.3	Specify precautions when welding fuel tanks and other flammable fluid containers.	2
11.2	**Welding Symbols**	
	Study Ref. 3	
11.2.1	Identify commonly used welding symbols on drawings and diagrams.	1
11.3	**Weld Joints**	
	Study Ref. 3	
11.3.1	Describe the various types of welded joint design, the preparation and the relative advantages, disadvantages and limitations of each.	1
11.3.2	State the depth of weld penetration that is considered desirable for each of the welded joints.	1
11.3.3	Describe why the edges of metal sheets may be bevelled and notched prior to butt-welding.	1
11.4	**Surface Preparation Prior to Welding**	
	Study Ref. 3	
11.4.1	Describe the methods of surface preparation for each welding process relative to various metal types. Include the requirement to remove such things as: a. cadmium plating. b. chrome plating. c. paint. d. corrosion. e. contaminants. f. anodising.	1

11.5	**Weld Defects** *Study Ref. 3*	
11.5.1	Identify weld defects relating to each of the common aeronautical welding processes and an acceptable means of inspection for each.	1
11.5.2	Identify indications of where excessive acetylene or excessive heat has been used in the gas welding process.	1
11.5.3	Specify how overheating, burning and buckling is overcome in the various welding processes.	1
11.5.4	Describe the specific heat treatment processes to be applied to components after welding has taken place.	1
11.6	**Metal Cutting** *Study Ref. 3*	
11.6.1	Outline the gas cutting; process, techniques, equipment and precautions associated with cutting various types and thickness of metal.	1
11.7	**Welding Terminology** *Study Ref. 3*	
11.7.1	State the significance of the following terms: a. Heat affected zone b. Total weld c. Angle and direction of travel d. Deoxidisers e. Arc stream f. Gaseous shield g. Molten pool h. Weld build-up i. Depth of penetration j. Protection from oxygen	1
11.8	**Welding Gasses** *Study Ref. 3*	
11.8.1	Specify the nature and purpose of the various gasses used in welding processes.	1
11.9	**Flame Types and Their Applications** *Study Ref. 3*	
11.9.1	Identify and describe the types of flame used in gas welding with particular emphases on carburising, oxidising and neutral flames. Give examples of where each would be used for various ferrous and non-ferrous metals.	2
11.9.2	Identify the flame type that would be most suitable for silver soldering.	1
11.10	**Welding Aircraft Structure and Components** *Study Ref. 3*	

11.10.1	Describe procedures and techniques relating to the welding of specific aircraft parts and structure including the following: a. Molybdenum steel tubing and tube clusters b. Splicing of tubular structure c. Rosette welds d. Inner and outer sleeves e. Welded patch repairs f. Engine mount repairs g. Axle assemblies h. Welding of exhaust stacks on piston engines i. Combustion chambers and liners	1
11.10.2	Describe the purpose of backup strips when carrying out overhead butt welds.	1
11.10.3	State how distortion can be minimised while butt-welding metal plates.	1
11.11	**Soldering and Brazing** *Study Ref. 2 & 8*	
11.11.1	From available reference data, state the chemical composition of solder and the effect that varying the tin/lead level has on solder melting point.	1
11.11.2	State the types and purpose of flux. Give the reason why flux must be removed after soldering.	2
11.11.3	Define "tinning" and describe the effect of excessive tinning on wire conductors.	2
11.11.4	State the tool used to prevent excessive tinning and why soldering iron tips are tinned.	2
11.11.5	Compare the differences between "soft" and "hard" (silver) soldering. State the advantage of using either method and the respective techniques and practices employed in the processes.	1
11.11.6	Identify cold joints.	2
11.11.7	State the reasons for the use of heat sinks and solder removing devices. For example, suckers and braid.	2
11.11.8	Describe correct methods of wrapping to be used on various types of electrical terminals.	2
11.11.9	Specify the purpose and procedures for brazing, with particular emphasis on the following: a. Metals which can be satisfactorily brazed b. Copper brazing c. Aluminium brazing d. Brazing limitations and strength e. Brazing theory f. Material preparation g. Brazing fluxes h. Pre heating i. Type of flame j. Filler rods k. Post brazing cooling and cleaning	1

12.Bonded Honeycomb Structure

12	Bonded Honeycomb Structure	
12.1	**Terminology** *Study Ref 2, 4 & 8*	
12.1.1	With regard to metal bonded honeycomb material, describe the following: a. Bond line b. Core c. Facing sheets d. Nodes e. Cell edge f. Ribbon dimension and direction g. Fatigue elimination h. Potted compounds	1
12.2	**Use of Metal Bonded Honeycomb** *Study Ref 2, 4 & 8*	
12.2.1	Identify areas of aircraft primary and secondary structure on modern aeroplanes and rotorcraft where it could be expected that metal bonded honeycomb is used.	1
12.2.2	State the advantages and features of metal bonded honeycomb used in aircraft construction.	1
12.3	**Non-Metal Bonded Honeycomb Structure**	
12.3.1	State where on an aircraft non-metal bonded honeycomb structure would typically be used.	1
12.3.2	State the advantages and features of non-metal bonded honeycomb used in aircraft construction.	1
12.4	**Radomes** *Study Ref 2, 4 & 8*	
12.4.1	Describe the following activities relating specifically to radomes: a. Handling, installation and storage b. Detection and removal of oil and water c. Inspection and classification of damage d. Common repairs e. Testing of repairs including structural integrity and electrical characteristics	1
12.5	**Repair Processes** *Study Ref 2, 4 & 8*	

12.5.1	Describe repair processes relating to metal bonded honeycomb structure with particular regard to the following: a. Causes of damage including delamination and the adverse effects of water or moisture penetration of the core material b. Damage inspection including "ring tests" c. Damage evaluation and classification d. Restoration of original strength e. Tools and equipment f. Routers and the routing of damaged areas g. Pressure jigs h. Infrared heat lamps i. Fire precautions j. Cleaning solvents; usage and safety k. Cleaning techniques and water break tests l. Primers, their purpose and application m. Adhesives and resins n. Core materials o. Erosion and corrosion preventives p. Potted compound repairs	2
12.5.2	In relation to the repair of metal bonded materials, describe the following: a. Typical repair procedures b. Repair of delaminations c. Damage to laminate structure d. Repairs to sandwich structure e. Repairs to honeycomb structure f. Use of doublers to restore original strength g. Glass fabric cloth overlays h. One skin and core repair procedures i. Lightning protection j. Painting of composite parts k. Storage, packing and protection of composite materials	2
12.5.3	Describe the following pressure applying techniques: a. Shot bags b. Clecos c. Spring clamps d. Peel ply e. Vacuum bagging	1
12.5.4	Describe the following methods of curing: a. Room temperature curing b. Heat curing	1
12.6	**Testing Methods** *Study Ref 2, 4 & 8*	
12.6.1	Specify methods of non-destructive inspection applicable to composite materials and know the limitations of each.	1
12.7	**Facilities** *Study Ref 2, 4 & 8*	
12.7.1	Describe the setup of a composite shop with regard to special facilities and equipment.	1

13. Transparent Plastics

13	Transparent Plastics	
13.1	**Types of Transparent Plastics** *Study Ref 2 & 8*	
13.1.1	Describe the characteristics of the following types of transparent plastics and state typical uses: a. Thermoplastics b. Thermosetting plastics	1
13.1.2	Describe the characteristics of acrylic and cellulose acetate plastics.	1
13.1.3	Describe the use and characteristics of laminated plastics.	1
13.1.4	State optical considerations relating to plastics.	1
13.1.5	Specify the advantages of stretched acrylic plastic for aircraft windows.	1
13.1.6	Identify in-situ tests to distinguish between acrylic and acetate plastics.	1
13.1.7	Describe the construction and installation methods for windows and windshields.	1
13.1.8	Identify the various types of transparent plastics by way of edge colour and MIL Spec.	1
13.2	**Forming and Fabricating** *Study Ref 2 & 8*	
13.2.1	Specify forming and fabricating procedures for transparent plastics including the following: a. Cutting b. Drilling and drill bit cutting/clearance angles c. Cementing d. Heat treatment e. Re-forming f. Removal of masking paper adhesive g. Products used for cleaning	1
13.2.2	Specify common installation procedures and precautions relating to transparent plastics including the following: a. Typical expansion and contraction allowances b. Bolt and rivet mounting c. Synthetic fibre edge attachment	2
13.2.3	Describe the coefficient of expansion of transparent plastic materials relative to aluminium and how these factors impact on installation processes.	2
13.2.4	State factors to be considered when proposing to repair transparent plastics fitted to pressurised aircraft.	1
13.2.5	Describe the method of forming acrylic sheet into final shape by hot and cold means.	1
13.2.6	Specify precautions and considerations when cutting and drilling acrylic materials.	2
13.2.7	State the methods, materials and general principles involved in cementing and curing acrylics.	2
13.2.8	Describe methods of finishing acrylic components by sanding, buffing and polishing.	2

13.2.9	Describe general cleaning techniques and precautions for the protection of installed transparent components.	2
13.2.10	Specify the properties of various types of clear plastic materials used for windows and windscreens.	2
13.3	**Handling and Storage** *Study Ref 2 & 8*	
13.3.1	Specify storage, protection and cleaning procedures for transparent plastics.	2
13.3.2	State how transparent plastics are polished.	2
13.3.3	Describe the types of protection and the respective ambient temperature ranges, for sun protection of acrylic cockpit windows.	1

14.Composite Materials

14	Composite Materials	
14.1	**Terminology**	
	Study Ref 2, 4 & 8	
14.1.1	Define the following terms and specify their interaction in typical composite structure: a. A-stage b. B-stage c. C-stage d. Accelerator e. Autoclave f. Balanced laminate g. Bi-directional fabric h. Bleeder i. Blocking j. Bridging k. Catalyst l. Caul plate m. Core separation n. Core splicing o. Crazing p. Cure q. Cure stress r. Exothermic reaction s. Fabric – plain, satin and twill weave t. Fibre – content u. Fibre – direction v. Fill (weft, woof) w. Finish x. Gel condition y. Glass (E and S) z. Carbon FRP aa. Glass FRP bb. Inhibitor cc. Kevlar (Aramid) dd. Kevlar FRP ee. Lamination sequence (Stacking or nesting) ff. Lay up gg. Matrix hh. Micro cracking ii. Mould release agent jj. Peel ply kk. Ply orientation ll. Porosity mm. Post-cure nn. Pot life oo. Prepeg pp. Reinforced plastic qq. Resin content rr. Resin richness ss. Resin starvation tt. Tracer uu. Unidirectional fabric vv. Void ww. Warp xx. Warp clock	1

14.2	**Material Working Procedures and Precautions** *Study Ref 2, 4 & 8*	
14.2.1	Specify the requirements and precautions relating to the storage and use of thermosetting polyester resins, accelerators and catalysts.	2
14.2.2	Specify the requirements and precautions related to the storage and use of epoxy resins and hardeners.	2
14.2.3	State the reasons for the permitted wide range of polyester resin/catalyst ratios and the tightly controlled resin/hardener ratios for epoxy systems.	1
14.2.4	Specify the requirements and precautions for storage and use of fibres, fibre fabrics, sandwich core materials and impregnated fibre fabrics.	2
14.2.5	Describe the construction of laminated amarid components used on aircraft, including the types of fibres used during the construction process.	1
14.2.6	Compare the advantages of using S-glass fibreglass cloth relative to other materials.	1
14.2.7	Describe the reasons for the use of surface finishes applied to fibres during production.	2
14.2.8	State the methods used to identify glass, boron, aramid and carbon fibre woven products.	1
14.2.9	State the reasons for the use of surface finishes applied to FRP composites.	1
14.2.10	Compare the advantages and disadvantages of each of the matrix/fibre combinations in general use.	1
14.2.11	State the reasons for use of the following: a. Different ply orientation in structural laminates b. GFRP and CFRP hybrid laminated structures c. Kevlar 49 sheeting d. Uni-directional and bi-directional fibre fabrics	1
14.2.12	Describe acceptable methods of surface cleaning and preparation prior to repair. Specify the importance of good surface preparation and its relationship to successful repair.	2
14.2.13	Describe methods used to dry out wet laminates prior to repair and state why this step is necessary.	2
14.2.14	Specify precautions to be observed in relation to temperature/overheating and blistering.	2
14.2.15	Describe how to perform the following tests. Burn test Water break test	2
14.2.16	Describe the methods used to repair negligible damage.	2
14.2.17	State the general factors, which must be considered when applying FRP repair schemes. For example, strength, stiffness, ultimate strain and ply overlap related to patch repairs, mismatch of metal/composite strengths and cure stress.	1

14.2.18	Describe the techniques involved in carrying out a repair lay-up using: a. high temperature cures. b. plain fabrics. c. impregnated fabrics. d. room temperature cures.	1
14.2.19	Compare the advantages and disadvantages of using room temperature cure lay-ups.	1
14.2.20	Describe the use of bleeder plies, vacuum bags and autoclaves during the repair process.	1
14.2.21	Describe the following handling requirements and their application to successful repairs: a. Prepreg (thaw) temperature and humidity b. Prepreg storage temperature	2
14.2.22	Describe methods used to minimise galvanic corrosion between CFRP skins and metallic sub-structure.	2
14.2.23	Describe methods used to protect FRP structures from erosion.	1
14.2.24	Describe methods used to protect FRP components from moisture/temperature degradation and breakdown by aircraft fluids.	2
14.2.25	Specify accepted practices for cutting, sanding and drilling FRP composite structure.	2
14.2.26	Identify appropriate tool combinations for different FRP materials and state special precautions and handling requirements relating to their use.	2
14.2.27	Identify all of the items of safety equipment required for working with composite materials.	2
14.2.28	Describe the cloth lay-up direction to give maximum strength during a fibreglass repair.	1
14.2.29	Specify the precautions to be observed when adding catalyst and accelerator to polyester resin.	2
14.2.30	Specify the effect on cure rates of resin thickness when laminating fibreglass sheets.	1
14.2.31	Specify the effects of density and weave on fibreglass laminate strength.	1
14.2.32	Identify fibreglass skin material by noting the colour of the fibres.	1
14.3	**Defect Identification** *Study Ref 2, 4 & 8*	
14.3.1	Describe the following defects and state their causes: a. Resin defects b. Finishing process damage c. Lay up defects	2
14.3.2	Describe methods of ensuring that these defects do not occur in practice.	2