CIVIL AVIATION AUTHORITY OF FIJI

GUIDANCE MATERIAL

Aircraft Maintenance Engineer Licence – Examination Module 1A - Aeronautical Science (Mathematics & Physics)

[AMEL-EM1A]

Published by:

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

www.caaf.org.fj

PREFACE

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

This GM provides guidance to aircraft maintenance engineering personnel and CAAF staff on the acceptable means of compliance with the syllabus content in respect of written examinations for Module 1A - Aeronautical Science (Mathematics and Physics).

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

Chief Executive
Civil Aviation Authority of Fiji

Table of Contents

Eligibility Requirements

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

The written examinations acceptable to the Authority for Module 1A (Aeronautical Science – Mathematics and Physics) should comply with the syllabus contained in this Guidance Material (GM). Each examination will cover all topics and may sample any of the sub-topics.

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

Examination Overview: Module 1A

The pass mark for Module 1A - Aeronautical Science (Mathematics and Physics) is 70%. An application to sit an examination may be made directly to ASPEQ. Refer to https://caaf.aspeqexams.com/home for examination information.

General Examining Objective

The objective of the examination is to determine that the applicant for an AMEL has adequate knowledge of Module 1A – Aeronautical Science (Mathematics and Physics) to permit the proper performance, supervision and certification of aircraft maintenance at a level commensurate with the privileges of the various AMEL categories.

Knowledge Levels

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

Objectives: The applicant should be:

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

LEVEL 2: A general knowledge of the theoretical and practical aspects of the subject.
An ability to apply the knowledge.

Objectives: The applicant should be able to:

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

LEVEL 3: A detailed knowledge of the theoretical and practical aspects of the subject. ***A capacity to combine and apply the separate elements of knowledge in a logical and comprehensive manner.***

Objectives: The applicant should:

1. know the theory of the subject and the interrelationships with other subjects

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

Recommended Study Material

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

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

Publication List

Study Ref	Book Title	Author	ISBN
1	A & P Technician General Textbook	Jeppesen	0-88487-203-3
2	Aviation Maintenance Technician Series - General	Dale Crane	1-56027-422-0
3	Aircraft Engineering Principles	L. Dingle & M. Tooley	0-7506-5015-X
4	Dictionary of Aeronautical Terms	Dale Crane	1-56027-287-2
5	Aviation Mechanics Handbook	Dale Crane	1-56027-412-3
6	Physics for Today and Tomorrow	Tom Duncan	978-0-7195-4002-8

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 subjectmatter and the type of performance or activity required. The objectives are intended to be simple, unambiguous, and clearly-focussed outcomes to aid learning.

Knowledge levels – right hand column

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

Syllabus: Module 1A – Aeronautical Science (Mathematics & Physics)

1. Mathematics		
Study Ref. 1, 2, 3 & 5		
1.1	**Arithmetic**	
1.1.1	Identify and write arithmetical terms and signs.	2
1.1.2	Round decimal numbers.	2
1.1.3	Convert between fractions and decimals.	2
1.1.4	Perform calculations involving: a. Addition, subtraction, multiplication and division of whole numbers, fractions and decimals b. Percentages, ratios, proportions, powers, averages, squares, cubes, and square/cube roots c. Factors and multiples.	2
1.1.5	Calculate: a. Volumes of common engineering objects b. Areas of plain figures c. Surface areas of regular solids.	2
1.1.6	Perform calculations involving: a. The binary system of numbers b. The hexadecimal system of numbers.	2
1.2	**Algebra**	
1.2.1	Perform algebraic calculations involving: a. The addition, subtraction, multiplication and division of like and unlike terms b. Factors and brackets c. Indices, including negative fractional indices d. Transposition of formulae.	2
1.2.2	Solve: a. Linear equations. b. Simultaneous equations with one unknown. c. Quadratic equations with one variable.	2
1.3	**Graphs**	
1.3.1	Describe the nature and uses of graphs.	2
1.3.2	Construct graphs containing a. Linear functions b. Exponential functions c. Sine and cosine equations.	2
1.3.3	Extract performance data from graphs found in trade-related manuals.	2

1.4	**Geometry and Trigonometry**	
1.4.1	Describe simple geometrical constructions.	1
1.4.2	Calculate: a. The circumference, radius and diameter of a circle b. The length of any side of a right angled triangle using Pythagoras' theorem c. Any angle of a right angle triangle using sine, cosine, tangent and cotangent d. Any angle and the length of sides of various types of triangle.	2
1.4.3	Differentiate between polar and rectangular coordinates.	1
1.5	**Vectors**	
1.5.1	Differentiate between scalar and vector quantities with examples.	1
1.5.2	Perform vector calculations including: a. Additions and displacements of vector quantities b. Triangle of vectors c. Polygon of vectors d. Resultant forces e. Forces in equilibrium.	2

2. Measurement

Study Ref. 1, 2, 3, 4, 5 & 6

2.1	**International System (SI) of Measurement**	
2.1.1	List the base and derived SI units of measurement.	1
2.1.2	State the following metric prefixes, their symbols and standard form multiplier: a. Giga b. Mega c. Kilo d. Unit e. Milli f. Micro g. Nano h. Pico.	1
2.1.3	Convert from one metric value to another (e.g. km – nm).	2
2.2	**Other Systems of Measurement**	
2.2.1	State the British, US and SI units of measurement of the following quantities: a. Length b. Mass c. Weight d. Time e. Volume f. Speed g. Velocity h. Acceleration i. Fluid flow j. Density k. Area.	1
2.2.2	Identify which of the above are fundamental quantities.	2
2.3	**Standard Conversion Factors**	
2.3.1	State, from memory, the following standards in the British, US and Metric systems: a. Pounds in a kilogram b. Ounces to grams and grams to ounces c. Imperial pints/quarts/gallon relationship d. Litres in an Imperial/American gallon e. Mph in a knot f. Centimetres in an inch g. American gallons in an Imperial gallon h. Freezing point of water in ºC and ºF i. Degrees absolute zero, converting from ºC and ºF to 0K j. Weight of one Imperial gallon of water k. Weight of one litre of water l. Litres in a cubic metre m. Gravitational acceleration.	2
2.3.2	With reference to the standards listed above; perform calculations associated with the conversion from one standard to another.	2
2.3.3	Convert from one value to another between Metric, Imperial and US units.	2

3. Matter

Study Ref. 1, 2, 3, 4, 5 & 6

3.1	**Characteristics of Matter**	
3.1.1	Define the characteristics and general properties of matter in terms of: a. Volume b. Mass c. Attraction d. Weight e. Density f. Inertia g. Porosity h. Impenetrability.	2
3.2	**States of Matter**	
3.2.1	Identify the three states of matter.	1
3.2.2	Define the properties of the three states in respect of: a. How each changes state b. Melting and melting points c. Boiling and boiling points d. Evaporation.	2
3.3	**Structure of Matter**	
3.3.1	Explain the internal structure of an atom.	2
3.3.2	Define a chemical element.	2
3.3.3	Outline information contained in the periodic table.	2
3.3.4	Explain how electrons, protons and neutrons act in each of the three states of matter.	2
3.3.5	Specify the chemical composition of the following substances: a. Atoms b. Molecules c. Ions d. Mixtures e. Compounds f. Crystals g. Solutions h. Solvents.	2
3.3.6	Define the following in an aeronautical context: a. Gravity b. Specific gravity c. Relative density d. Energy e. Potential energy f. Kinetic energy g. Units of energy.	2
3.3.7	Solve simple problems relating to each of the above terms.	2

3.3.8	Define the basic theory of each of the following terms in relation to solids: a. Stress b. Strain c. Elasticity and Hooke's Law d. Tension e. Compression f. Shear g. Torsion h. Young's Modulus i. Hardness j. Ductility.	1

4. Atmosphere

Study Ref. 1, 2, 3, 4, 5 & 6

4.1	**Characteristics of the Atmosphere**	
4.1.1	Define the following standard atmospheric values: a. Sea level temperature in ºC and ºF b. Sea level pressure in inches of Mercury, PSI, millibars and SI units c. Standard pressure lapse rate d. Absolute pressure e. Gauge pressure.	2
4.1.2	Define the term ISA standard atmosphere.	1
4.1.3	Describe the relationship between temperature, pressure and density with varying altitude.	2
4.1.4	Differentiate between height and altitude.	2
4.2	**Atmospheric Layers**	
4.2.1	State the gaseous composition of the atmosphere.	1
4.2.2	Describe the following atmospheric layers: a. Troposphere b. Stratosphere c. Ionosphere.	1
4.2.3	Describe how viscosity affects the movement of air between atmospheric layers.	1
4.2.4	State where temperature-change with altitude is nearly constant.	1
4.3	**Pressure Measurement**	
4.3.1	Define ambient air pressure.	1
4.3.2	Describe how ambient air pressure acts on and around the surface of a body	1
4.3.3	Specify the properties of moving air in respect of Newton's laws of motion.	1
4.3.4	Define cabin altitude and describe its relationship to aircraft construction, operation, maintenance and passenger comfort.	1
4.3.5	Perform simple calculations relating to aircraft cabin pressure and altitude from given information.	2
4.3.6	Define "atmosphere" for pressure measurement.	1
4.3.7	Distinguish between the measurement of atmospheric pressure in the British, US and Metricsystems.	2
4.3.8	Explain the operation of aneroid and mercury barometers in measuring atmospheric pressure.	1

4.4	**Air Density**	
4.4.1	Describe the following criteria relating to air density: a. How it is measured b. The basic effects on aircraft and power plant performance c. The term density altitude.	2
4.4.2	Distinguish between density altitude and pressure altitude, with examples of where each phenomenon plays an important part in the performance or operation of an aircraft.	2
4.5	**Vapour and Humidity**	
4.5.1	Describe: a. Equation of state b. Atmospheric moisture and the effects of temperature changes on vapour retention c. Humidity and its relationship to air density d. Absolute humidity e. Relative humidity f. Dew point g. Water vapour h. Vapour pressure and vapour pressure variation with pressure differential i. Saturated air j. Fog and clouds k. Rain l. Wet bulb thermometer m. Wet and dry bulb temperatures n. Wet-bulb hygrometer o. Condensation and its cause (dew point/temperature relationship).	2
4.5.2	Describe the basic effects of fog, water vapour and humidity on the performance of piston andturbine engines.	2
4.6	**Atmospheric Phenomena**	
4.6.1	Describe the following atmospheric phenomena and their effects on aircraft operations, aircraftstructure and components: a. Lightning b. Glare and glare protection c. Frost d. Types of ice, the formation of ice e. Extremes of temperature f. Acid rain, dust and salt deposits g. Volcanic ash and smoke.	2
4.6.2	State why air is warmer near the earth's surface.	1

5. Mechanics

Study Ref. 1, 2, 3 & 6

5.1	**Turning Forces**	
5.1.1	Define the following with examples: a. Principle of moments and couples b. Resultant moments c. Centre of gravity d. Datum e. Fulcrum f. Equilibrium, static stability and dynamic stability.	2
5.1.2	Explain how moments and couples are represented.	1
5.1.3	Calculate the turning moments on a beam.	2
5.1.4	Describe the theory of torque measurement and its various applications in aviation, including calculations of torque values.	2
5.2	**Levers**	
5.2.1	In relation to levers and simple machines, describe: a. Forces b. Moments c. Couples.	2
5.2.2	Describe the theory and principles of first, second and third class levers.	2
5.2.3	With respect to the classes of levers, calculate a. Load b. Effort c. Mechanical advantage.	2
5.3	**Inclined Plane**	
5.3.1	Describe the effects of raising or lowering objects using an inclined plane.	1
5.3.2	Perform calculations relating to the use of an inclined plane.	2
5.4	**Pulleys**	
5.4.1	Describe common pulley systems with a mechanical advantage of 1, 2 and 4.	1
5.4.2	With respect to each system, calculate: a. Load b. Effort c. Velocity ratio d. Mechanical advantage.	2
5.5	**Centre of Gravity**	
5.5.1	Define aircraft centre of gravity.	1
5.5.2	Perform calculations using positive and negative moments.	2

5.6	**Gears**	
5.6.1	Describe the aeronautical applications for gear systems.	1
5.6.2	Define the following: a. Driver gear b. Driven gear c. Idler gear d. Gear ratio. e. Velocity ratio. f. Mechanical advantage. g. Efficiency.	1
5.6.3	Perform calculations involving: a. Mechanical Advantage (MA) b. Velocity Ratio (VR) c. Efficiency (E).	
5.6.4	Describe the following gear systems: a. Spur b. Bevel c. Helical d. Worm e. Planetary.	1
5.6.5	Describe how changes to speed and direction of rotation are achieved in different gear systems.	2
5.6.6	Compare the advantages and disadvantages of each gear system.	1
5.6.7	Describe the different configurations of gears on a shaft.	1
5.7	**The Screw Jack**	
5.7.1	Describe the theory of operation of a screw jack.	2
5.7.2	Solve simple lifting problems.	2

6. Kinetics

Study Ref. 1, 2, 3 & 6

6.1	**Motion**	
6.1.1	Define the following terms: a. Distance b. Time c. Velocity d. Acceleration e. Speed f. Momentum.	2
6.1.2	Explain the accelerated motion of a free-falling body.	2
6.1.3	Using the laws of motion formulae, solve simple problems relating to: a. Acceleration b. Velocity c. Distance d. Time.	2
6.1.4	Differentiate between: a. Average speed b. Displacement c. Acceleration d. Velocity.	1
6.1.5	Outline the purpose of velocity time graphs.	
6.1.6	Describe linear movement, including: a. Uniform motion in a straight line b. Motion under the force of gravity.	2
6.1.7	Describe rotational movement, including: a. Uniform circular motion b. Centripetal and centrifugal forces c. Centripetal acceleration.	1
6.1.8	State the relationship between centrifugal force and speed in a rotating body.	1
6.1.9	Describe periodic motion in relation to: a. Motion in a circle at constant speed b. Energy relations in simple harmonic motion c. Movement of a pendulum d. Angular harmonic motion e. Equilibrium in a dynamic system.	1
6.1.10	Define Newton's three laws of motion with examples.	1
6.1.11	Perform calculations involving Newton's laws of motion.	2
6.1.12	In relation to matter, describe: a. Vibration b. Harmonics c. Resonance d. Damped harmonic motion e. Forced harmonic motion.	1

7. Dynamics

Study Ref. 1, 2, 3 & 6

7.1	**Terms and Units of Measurement**	
7.1.1	Define the following terms, with practical aeronautical examples: a. Force b. Resultant force and equilibrium c. Gravity d. Inertia e. Work f. Power g. Energy (Potential, Kinetic and total) h. Efficiency i. Conservation of momentum j. Momentum and impulse k. Torque l. Moment of inertia m. Radius of gyration n. Rotational equilibrium o. Centre of mass p. Couples q. Two-dimensional motion r. Rolling bodies.	1
7.1.2	State the units of measurement for each of the terms above.	
7.1.3	Perform calculations relating to simple aeronautical applications for each of the above terms.	2
7.1.4	Calculate: a. Forces parallel to displacement b. Forces not parallel to displacement.	2
7.1.5	Describe the basic operation of a simple gyroscope.	1
7.2	**Fluids**	
7.2.1	In relation to fluids, describe: a. Specific gravity and density b. Viscosity c. Fluid volatility d. Fluid resistance e. Effects of streamlining f. Effects of compressibility g. Static, dynamic and total pressure h. Pressure and buoyancy (Includes the principles of a barometer) i. Bernoulli's Theorem j. The venturi.	2
7.2.2	Differentiate between liquids and gasses, with particular respect to: a. Compressibility b. Flow c. Force d. Expansion.	1

7.2.3	Perform calculations related to aircraft fuel loads, including: a. Fuel conversions b. Variation in temperature c. Fuel specific gravity.	2
7.2.4	Describe the nature of fluid flow through a venturi tube including: a. Velocity b. Pressure.	2
7.2.5	Solve simple flotation problems of an aeronautical nature using Archimedes' Principle.	2
7.2.6	Outline the principle of operation and use of a hydrometer.	2
7.3	**Transmission of Force Through Fluids**	
7.3.1	Relating to hydraulic and pneumatic power systems, describe: a. Force and pressure b. Pascal's principles c. Computing force, pressure and area d. Multiplication of forces e. Differential areas f. Volume, distance and area factors g. Effects of atmospheric pressure.	2
7.3.2	Perform calculations involving the criteria listed above.	
7.3.3	Solve simple problems relating to the use of: a. Hydraulic press b. Hydraulic actuator c. Pressure-operated valve.	2
7.4	**Friction**	
7.4.1	Describe the following types of friction with examples of where each may be found within an aircraft: a. Static (starting) b. Sliding c. Rolling d. Fluid.	1
7.4.2	Define the term "coefficient of friction".	1
7.4.3	Explain the importance of coefficient of friction for aircraft construction and operation.	2
7.4.4	Outline the factors that affect friction on: a. A sliding surface b. Rotating components.	2
7.4.5	Describe how frictional effects can be modified.	2
7.4.6	Solve practical problems relating to frictional forces, using formulae.	2
7.4.7	Compare the advantages and disadvantages of friction within aeronautical engineering.	2

7.4.8	Diagnose common defects found in aircraft components that have arisen as a result of excessivefriction, including: a. Overheating b. Excessive/premature wear-out c. Faying surface deterioration.	3

8. Thermodynamics

Study Ref. 1, 2, 3 & 6

8.1	**Heat**	
8.1.1	Define the following terms: a. Latent heat b. Latent heat of fusion c. Latent heat of evaporation (vaporisation) d. Cooling produced by evaporation e. Expansion and coefficient of linear expansion f. Expansion of solids and liquids g. Volumetric expansion h. Specific heat i. Sensible heat j. Heat capacity k. Heat definition l. Heat transfer by conduction, convection and radiation m. Radiant energy n. Thermal energy o. Heat of combustion p. Mechanical equivalent of heat.	1
8.1.2	State practical aeronautical applications for each of the terms listed above.	1
8.1.3	Solve problems relating to terms listed in 8.1.1.	2
8.1.4	Explain how thermal expansion is used in the operation of a bi-metallic strip.	2
8.1.5	Describe in practical terms, the first and second laws of thermodynamics.	1
8.1.6	Identify the following: a. The ability of various aircraft materials to conduct heat. b. Types of surfaces that radiate or absorb heat more readily c. How heating/cooling is affected in aircraft using the three methods of heat transfer.	2
8.1.7	Define the following units of heat: a. Calorie (cal) b. British Thermal Unit (Btu) c. Joule (J).	1
8.1.8	Calculate: a. The calorific value of fuels. b. Energy and power production in a heat engine.	2
8.1.9	Describe how water pipes are affected when water freezes.	2
8.2	**Temperature**	
8.2.1	Describe the following thermometers: a. Alcohol b. Mercury c. Resistance d. Thermistor e. Thermocouple.	1

8.2.2	Convert between the following temperature scales. a. Centigrade (Celsius) scale b. Fahrenheit scale c. Kelvin scale d. Rankine scale.	2
8.2.3	Identify freezing and boiling points on each of the temperature scales.	1
8.2.4	Describe the boiling point of a fluid in terms of saturated vapour pressure and atmospheric pressure.	2
8.3	**Gas Laws**	
8.3.1	Outline the following: a. Boyle's Law b. Charles' Law c. General gas laws d. Dalton's law e. Kinetic theory of gasses f. Relationship between internal energy and heat.	2
8.3.2	Perform calculations related to the above laws and theories.	2
8.3.3	Explain the effects of expanding gasses	1
8.3.4	Illustrate the temperature rise that takes place during compression of a gas.	
8.3.5	Explain the following terms: a. Specific heat at constant volume and constant pressure b. The state of dynamic equilibrium between a vapour and a liquid c. Isothermal expansion and compression d. Adiabatic expansion and compression e. Engine cycles f. Constant volume g. Constant pressure h. Refrigerators i. Heat pumps.	1

9. Optics

Study Ref. 1, 2, 3 & 6

9.1	**Light**	
9.1.1	Describe the following: a. Electromagnetic radiation b. Transverse waves c. Light transmission d. The nature of light.	1
9.1.2	State the frequency range and speed of light.	1
9.1.3	Define the laws of refraction and reflection.	1
9.1.4	Outline how the above laws are applied in the following devices: a. Lenses b. Cameras c. Telescopes d. Microscopes.	
9.1.5	Describe the reflection and transmission of light: a. from flat, concave and convex surfaces. b. through a concave lens. c. through a convex lens.	1
9.1.6	Describe: a. The visual results gained from using these lenses. b. How convex and concave lenses can be used when conducting practical inspection tasks.	
9.1.7	Describe: a. The transmission of light through an optical fibre cable b. Factors that will affect the transmission.	1

10. Wave Motion and Sound

Study Ref. 1, 2, 3 & 6

10.1	**Definitions and Terms**	
10.1.1	Define the following terms relating to sound: a. Wave motion and mechanical waves b. Longitudinal waves c. Sinusoidal wave motion d. Standing waves e. Interference phenomena f. Amplitude g. Decibels h. Hertz (Hz) i. Speed of sound j. Subsonic k. Transonic l. Supersonic m. Mach number n. Doppler Effect o. Frequency including natural frequency in a body p. Resonance q. Threshold of audibility r. Threshold of feeling s. Compression t. Rarefaction u. Vibrations v. Reverberation w. Propagation x. Shock waves.	1
10.1.2	In relation to sound, describe: a. How it is produced. b. Factors affecting its intensity, pitch and quality. c. Behaviour of the waves.	1
10.1.3	Specify how atmospheric changes affect sound transmission.	1
10.1.4	Describe the transmission of sound through solid and gaseous mediums.	1
10.1.5	Specify how noise intensity may be attenuated.	2
10.1.6	Identify sound reducing materials and insulation techniques.	1
10.1.7	Explain: a. How resonance is caused in a body b. The adverse effects resonance can have on aircraft structure or aircraft components.	2