Subject No 26 Aircraft Technical Knowledge (Aeroplane)

Note: This syllabus is primarily based on a piston-engine light twin aeroplane.

Each subject has been given a subject number and each topic within that subject a topic number. These reference numbers will be used on 'knowledge deficiency reports' and will provide valuable feed back to the examination candidate. These reference numbers are common across the subject levels and therefore may not be consecutive.

This syllabus presupposes a knowledge and understanding already attained at PPL level.

Sub Topic	Syllabus Item
26.8	**Electricity and Magnetism - Advanced**
26.8.1	Explain the basis of an electrical current, and the direction of the current.
26.8.2	Describe the basic characteristics of an electrical flow using the terms [amps, volts, electromagnetic force (emf) and ohms].
26.8.3	State Ohm's law.
26.8.4	With the aid of diagrams, describe simple 'two-wire' and 'single wire' grounded electrical circuits.
26.8.5	Distinguish between direct and alternating current, and explain the terms 'Hertz' and 'rectification'.
26.8.6	Describe the properties of magnetism, including polarity, attraction and repulsion.
26.8.7	Distinguish between temporary and permanent magnets, and the properties of 'soft iron' and 'hard iron'.
26.8.8	Describe the terms magnetic field, magnetic flux, and permeability.
26.8.9	Explain 'electromagnetism' and with the aid of diagrams, show the lines of magnetic force around a straight conductor and a coil.
26.8.10	With the aid of diagrams, describe the principle of operation of an electromagnetic switch (or relay) and a solenoid switch. Describe typical examples of their use in aircraft electrical circuits.
26.8.11	Explain the principle of electromagnetic induction.
26.8.12	With the aid of a diagram, describe the principle of operation of a simple alternator (a magnet rotating inside a loop conductor).

Sub Topic	Syllabus Item
26.8.13	Show the features of a practical alternator, and explain how the AC output is normally rectified to provide DC.
26.8.14	With the aid of a diagram, describe the principle of operation of a simple generator (a loop conductor rotating inside a magnet).
26.8.15	Show the features of a practical generator, and explain how the output is passed through a commutator to provide DC.
26.8.16	Explain the need for voltage regulation for both alternators and generators, and how a generator also requires a current regulator and a reverse current relay.
26.8.17	Explain the principle of operation of a battery.
26.8.18	Distinguish between primary and secondary cells, wet-cells and dry cells, lead-acid and nickel-cadmium (and similar) types.
26.8.19	Explain the meaning of : (a) battery capacity; (b) thermal runaway.
26.8.20	Explain the basic features and operation of: (a) a lead-acid battery; (b) a nickel-cadmium (nicad) battery.
26.8.21	State the advantages of NiCad batteries.
26.11	**Hydrodynamics - Advanced**
26.11.1	State Pascal’s principle.
26.28	**Weight and Balance**
26.28.1	Define the following terms: (a) arm; (b) datum; (c) moment (including the units used); (d) centre of gravity (CG);

Sub Topic	Syllabus Item
	(e) CG range and limits;
	(f) station;
	(g) index units;
	(h) basic empty weight (empty aircraft weight);
	(i) empty weight CG position;
	(j) basic operating weight (aircraft prepared for service weight);
	(k) payload;
	(l) zero fuel weight;
	(m) ramp weight;
	(n) gross weight;
	(o) maximum certificated take-off weight (MCTOW);
	(p) maximum certificated landing weight (MCLW);
	(q) specific gravity and the weight of fuel.
26.28.2	Explain:
	(a) the principles of aeroplane balance, and the function of the tailplane in providing the final longitudinal balancing force;
	(b) the significance of lateral fuel imbalance and the limitations typically applied.
26.28.3	Describe the effect on longitudinal stability and handling with the aeroplane loaded with the CG:
	(a) forward;
	(b) outside the forward limit;
	(c) aft CG;
	(d) outside the aft limit.
26.28.4	Given weights and arms, calculate moments and establish a CG position.
26.28.5	Demonstrate the use of graphs to:
	(a) calculate load moment;
	(b) establish CG position.

Sub Topic	Syllabus Item
26.28.6	Given appropriate data and using a typical weight and balance work sheet, calculate the CG position at take-off and for landing.
26.28.7	Solve the following loading problems: (a) loading or offloading weight and find new CG position; (b) loading or offloading weight to place the CG at a given station; (c) loading or offloading weight at a given station without exceeding CG limits; (d) moving weight from one station to another and finding new CG position; (e) establishing payload available given a maximum zero fuel weight.
26.31	**Airframe Structure**
26.31.1	Explain different types of loading which an airframe must be designed to accept.
26.31.2	Explain the effects of the application of a load to an airframe structure (stress and strain) and differentiate between bending, tensile, compression, torsional and shear loads.
26.31.3	Briefly describe the various construction styles of a fuselage.
26.31.4	Briefly describe the common types of wing construction.
26.31.5	Briefly describe the construction of tailplane and fin, and control surfaces.
26.32	**Control Systems**
26.32.1	Briefly describe the method of operation of the primary control surfaces found in a piston-engine light twin aeroplane.
26.34	**Piston Engines**
26.34.1	Distinguish between the basic types of piston aircraft engine.
26.34.2	State the fundamental operating principle of the reciprocating (piston) engine.
26.34.3	With the aid of diagrams, identify the main components of a four-stroke cycle piston engine including: cylinders, pistons, cylinder heads, valves, spark plugs,

Sub Topic	Syllabus Item
	connecting rods, crankshaft, camshaft and valve operating mechanism.
26.34.4	With respect to a four-stroke piston engine, state the meaning of the following terms: cycle, stroke, top dead centre (TDC) and bottom dead centre (BDC), bore, clearance and swept volumes, compression ratio, firing interval, firing order, manifolds, manifold pressure and crank angle.
26.34.5	Explain the term ignition timing and the need for spark advance.
26.34.6	Distinguish between detonation and pre-ignition; state the main causes of these conditions, and the reasons for avoiding them.
26.34.7	Discuss diesel (compression ignition) knock and detonation.
26.34.8	Describe the use of a Ground Power Unit (GPU).
26.35	**Turbo Prop Engines**
26.35.1	Explain the basic differences between reciprocating (piston) and gas turbine (jet) engines.
26.37	**Engine Performance**
26.37.1	Define the terms: Engine Torque and Engine Power.
26.37.2	Relate horsepower to kilowatts.
26.37.3	Define rated power and explain the terms ‘rated altitude’ or ‘critical altitude’.
26.37.4	Explain the following in broad terms: thermal efficiency, mechanical efficiency, and volumetric efficiency.
26.37.5	With the aid of a diagram, explain the power available curve.
26.37.6	Explain the general conditions for the most efficient engine operation.
26.38	**Carburation**
26.38.1	Explain the following in relation to fuel-air mixture ratios: (a) ‘rich’ and ‘lean’; (b) the ‘chemically correct’ or stoichiometric ratio.

Sub Topic	Syllabus Item
26.38.2	With the aid of a diagram, describe a typical carburettor mixture setting curve and show the operating area where detonation may occur.
26.38.3	Explain the fuel-air ratios for achieving maximum power output and best economy.
26.38.4	Explain the need for the following in an aero-engine carburettor: (a) atomization and diffusion; (b) accelerating system; (c) idling system; (d) power enrichment (economizer) system; (e) mixture control and cut-off system.
26.38.5	Describe any disadvantages with use of a float-type carburettor in an aero-engine.
26.38.6	Explain the correct use of the mixture control.
26.38.7	Explain the consequences of operating with over-rich and over-lean mixture settings.
26.38.8	With respect to carburettor ice, explain the process and the atmospheric conditions for the formation of: (a) refrigeration (or fuel) ice; (b) throttle ice; (c) impact ice.
26.38.9	Explain the normal symptoms of carburettor ice formation, and the correct use of the carburettor heat control.
26.38.10	With respect to carburettor air intakes, explain the correct use of ram air, filtered air, carburettor heat.
26.38.11	Explain the reasons for a reduction in power when carburettor heat is operated.
26.38.12	Describe the typical source of carburettor heat hot air.

Sub Topic	Syllabus Item
26.39	**Fuel Injection**
26.39.1	Explain the principal differences between a fuel injection system and carburettor systems.
26.39.2	Explain the principal differences between continuous flow fuel injection, and direct fuel injection systems.
26.39.3	List the advantages and disadvantages of using fuel injection systems in aero-engines.
26.39.4	Explain the normal symptoms of intake ice formation, and the correct use of alternate air sources.
26.40	**Supercharging**
26.40.1	Explain the advantages, and the limitations of exhaust driven turbo charging and mechanically driven supercharging.
26.40.2	Explain the basic principle of operation of an exhaust-driven turbocharger.
26.41	**Exhaust System**
26.41.1	Explain the importance of proper sealing of the exhaust manifold.
26.41.2	Describe the possible sources and associated danger of carbon monoxide gas.
26.43	**Ignition Systems - Magnetos**
26.43.1	Explain the reasons for fitting independent dual ignition systems to aero-engines.
26.43.2	List the essential components of an ignition system.
26.43.3	Describe, in broad terms, the operation of the following: (a) an aircraft magneto; (b) impulse couplings; (c) the distributor; (d) ignition harness (high tension leads);

Sub Topic	Syllabus Item
	(e) spark plugs.
26.43.4	Describe the functioning and limitations of the starter motor, and outline the correct operation of a typical starter switch.
26.44	**Ignition Systems – Solid State**
26.44.1	Describe the operation and components of a typical solid state ignition system.
26.44.2	Explain the purpose and a typical procedure for conducting solid state ignition integrity checks.
26.44.3	Explain the significance of maintaining the power supply to a solid state ignition system and describe a typical backup system.
26.46	**Propellers**
26.46.1	Explain the main disadvantages of the fixed-pitch propeller, which the constant-speed (variable-pitch) propeller was designed to overcome.
26.46.2	For a constant speed propeller, differentiate between the functions of the propeller (pitch) control and the throttle control, when the propeller is: (a) in the constant-speed range; (b) below the constant-speed rpm range.
26.46.3	Explain how the constant-speed unit (CSU) acts to change the pitch of the blades and maintain rpm: (a) with changes to power; (b) with changes in airspeed.
26.46.4	With the aid of diagrams, explain the method of operation of typical pitch-changing mechanisms.
26.46.5	With the aid of a diagram, explain the operation of a typical CSU governor.
26.46.6	Explain the power management requirements as the propeller blades are traveling from the normal thrust to the reverse thrust angle.
26.46.7	Describe the normal handling of the propeller pitch and power controls for a two lever control system: (a) when the aircraft is on the ground;

Sub Topic	Syllabus Item
	(b) for ‘exercising’ the CSU;
	(c) prior to take-off and landing;
	(d) when increasing or decreasing power in the air.
26.46.8	Describe the normal handling of the power control for a single lever control system:
	(a) when the aircraft is on the ground;
	(b) for ‘exercising’ the CSU;
	(c) prior to take-off and landing;
	(d) when increasing or decreasing power in the air.
26.46.9	Describe the types of failure which can affect the CSU, including the conditions which can lead to a ‘runaway propeller’ and the required remedial action.
26.46.10	Describe the function and operation of a:
	(a) manual feathering propeller;
	(b) auto-feather propeller;
	(c) auto-coarsen propeller.
26.48	**Hydraulic System**
26.48.1	With the aid of diagrams:
	(a) describe mechanical advantage;
	(b) show how this can be gained hydraulically;
	(c) describe the principle of operation of typical aircraft hydraulic services.
26.48.2	Explain the advantages of using hydraulics to operate aircraft services.
26.48.3	Differentiate between the three types of hydraulic oil. State any limitations and appropriate use of each type.
26.48.4	Describe the function of common hydraulic system components:
	(a) reservoirs;
	(b) pumps;

Sub Topic	Syllabus Item
	(c) pressure regulators;
	(d) accumulators;
	(e) check valves and relief valves;
	(f) selector valves;
	(g) actuators;
	(h) filters.
26.48.5	With the aid of schematic diagrams, describe the operation of a typical hydraulic system.
26.50	**Pneumatic System**
26.50.1	Briefly explain the advantages and disadvantages of pneumatic systems versus hydraulic systems.
26.50.2	With the aid of schematic diagrams, outline the operation of a typical pneumatic system.
25.52	**Electrical System - DC**
26.52.1	Detail the systems which typically require DC power in an aircraft.
26.52.2	Explain the function(s) of the following in a typical aircraft electrical system:
	(a) the battery;
	(b) a ground power source;
	(c) the alternator or generator;
	(d) bus bars;
	(e) over voltage protection.
26.52.3	Distinguish between the way in which fuses, circuit breakers and overload switches operate.
26.52.4	Explain operational principles for the handling of the electrical DC system, including:
	(a) avoiding overheating electrical services if operated during pre-flight;
	(b) not starting or stopping the engine with unnecessary electrical equipment switched on;

Sub Topic	Syllabus Item
	(c) checking satisfactory operation of the alternator/generator after start, and periodically during flight;
	(d) use of a ground power unit.
26.52.5	Explain the diagnosis and dangers in the handling of electrical malfunctions including:
	(a) an excessive charge rate;
	(b) alternator/generator failure;
	(c) resetting of blown fuse/popped circuit breakers;
	(d) use of fuses as a switch;
	(e) issues related specifically to “technically enhanced aircraft” (TEA).
26.55	**Landing Gear - Fixed**
26.55.1	Explain the requirements which the undercarriage system must be able to meet.
26.55.2	Describe the features of undercarriage construction; explain the operation of an oleo-pneumatic shock strut.
26.55.3	Describe the pilot checks of oleo-pneumatic undercarriage legs.
26.55.4	Describe the construction of aircraft wheel assemblies and tyres.
26.55.5	Explain the requirements for tyre care and checks.
26.56	**Landing Gear - Retractable**
26.56.1	Describe the essential features of a retractable undercarriage system.
26.56.2	Explain and define the speed limitations for landing gear operation.
26.56.3	Describe typical emergency gear operation systems and procedures.
26.56.4	Describe typical gear warning and indicating systems.
26.56.5	Describe the function and operation of ground retraction protection systems.
26.58	**Aircraft Wheel Brake System**

Sub Topic	Syllabus Item
26.58.1	Describe principle of operation of the common types of wheel brake units.
26.58.2	Outline the operation of: (a) an independent brake system; (b) a boosted brake system; (c) a power brake system.
26.58.3	Explain the operation of anti-skid brake systems.
26.60	**Fuel**
26.60.1	Explain the differences between aviation gasoline (AVGAS) and motor gasoline (MOGAS).
26.60.2	Explain fuel octane ratings and performance numbers.
26.60.3	List the types of fuels available in New Zealand, together with their colours.
26.60.4	Explain the likely result of using a higher grade, or a lower grade, of fuel than that recommended for a given aircraft.
26.60.5	Explain the caution against using automobile fuel (MOGAS) in an aircraft engine, unless specifically authorized.
26.60.6	Describe the distinguishing features of aviation turbine fuel (AVTUR) and state the difference between the decals used on AVTUR and AVGAS fuelling equipment.
26.60.7	Explain the precautions which can be taken to avoid fuel contamination with water and other impurities.
26.60.8	Explain the special precautions which must be taken when fuelling from drum stock, and the avoidance of the use of non-approved plastic containers.
26.60.9	Describe the correct procedures to be used for carrying out a fuel check.
26.61	**Fuel Pumps**
26.61.1	Distinguish between gravity-feed and pump-feed fuel systems.
26.61.2	For a fuel system, explain the function, and where appropriate, the correct handling of the following:

Sub Topic	Syllabus Item
	(a) engine-driven fuel pump;
	(b) boost (auxiliary) pump(s);
	(c) engine primers and priming systems.
26.62	**Fuel Tanks**
26.62.1	Describe the importance of correct management of fuel selection.
26.62.2	Detail the actions recommended in the case of loss of power through faulty fuel selection.
26.62.3	Describe the general rules for refueling an aircraft, and the correct use of fuel tank dipsticks and magna-sticks.
26.62.4	For a fuel system, explain the function, and where appropriate, the correct handling of the following:
	(a) tank filler caps and drains;
	(b) expansion spaces;
	(c) tank vents;
	(d) baffles;
	(e) sumps and drains;
	(f) fuel quantity detectors;
	(g) fuel strainers and filters;
	(h) tank selector valves;
	(i) cross feed valves;
	(j) fuel flow meters.
26.62.5	Describe the common methods of cross feeding fuel.
26.64	**Cooling Systems - Engines**
26.64.1	Explain the reasons why excessively high engine temperatures and rapid cooling must be avoided.
26.64.2	Describe the ways in which heat from the combustion process is dispersed from a typical aero-engine.

Sub Topic	Syllabus Item
26.64.3	In a typical aircraft engine, explain the function of: (a) cowling ducts and baffles; (b) cooling fins; (c) pilot-operated cowl flaps; (d) oil cooler; (e) radiator; (f) intercooler.
26.64.4	Explain the general engine handling techniques for maintaining engine temperatures within the proper range, for aircraft: (a) without CHT gauge or cowl flaps; (b) fitted with CHT gauge and cowl flaps.
26.66	**Lubrication Systems - Engines**
26.66.1	Explain the main functions of the engine oil system.
26.66.2	Compare the features of the ashless dispersant (AD) oils used in piston aero-engines with straight mineral oil and detergent oils.
26.66.3	With respect to oil grades, differentiate between the commercial aviation numbers and SAE ratings and the significance of the oil grade.
26.66.4	Explain the need for periodic oil changes.
26.66.5	Describe the likely results of operating an engine with: (a) incorrect oil type; (b) incorrect oil quantity.
26.66.6	Describe the likely causes of: (a) low oil pressure; (b) high oil pressure; (c) high oil temperature.
26.66.7	Explain the relationship between a fluctuating or low oil pressure reading accompanied by a rise in oil temperature, and the actions which the pilot should

Sub Topic	Syllabus Item
	take.
26.68	**Warning Systems**
26.68.1	Outline the operation of a typical fire detection system.
26.69	**Protection Systems**
26.69.1	List the common extinguishing agents and state any precautions when using.
26.69.2	Describe common fire extinguishing systems and the limitations with their use.
26.71	**Ice and Rain Protection Systems**
26.71.1	Distinguish between anti-icing systems and de-icing systems.
26.71.2	Explain the operation and the proper handling of, mechanical, fluid and thermal ice protection systems.
26.71.3	Describe ice detection, windscreen heating and rain clearance systems.
26.71.4	Describe the performance reductions associated with: (a) ice accumulation; (b) operation of anti-ice and de-icing equipment.
26.71.5	Explain the function and operation of static discharge wicks and bonding strips.
26.73	**Engine Instruments**
26.73.1	Explain the underlying principle of operation of the following: (a) tachometers; (b) manifold pressure and boost gauges; (c) oil pressure gauges; (d) fuel pressure gauges; (e) vacuum gauges.
26.73.2	Describe the principle of operation of the following instruments: (a) cylinder head and exhaust gas temperature (thermocouples);

Sub Topic	Syllabus Item
	(b) oil temperature gauges;
	(c) outside air temperature gauges;
	(d) fuel quantity, fuel flow gauges and fuel flow gauges.
26.74	**Pressure Instruments**
26.74.1	Explain the function of pitot heat.
26.74.2	Explain the following errors affecting an ASI:
	(a) density error (IAS/TAS relationship);
	(b) position (pressure) error;
	(c) compressibility error.
26.74.3	Describe the pre-flight and in-flight serviceability checks for an ASI.
26.74.4	Explain the following errors affecting an altimeter:
	(a) instrument;
	(b) position error;
	(c) lag.
26.74.5	Describe the serviceability checks and the accepted indication tolerances of an altimeter system.
26.74.6	With the aid of a diagram, explain the principle of operation and limitations of:
	(a) a vertical speed indicator (VSI);
	(b) instantaneous vertical speed indicator (IVSI).
26.74.7	Explain the following errors affecting a VSI;
	(a) lag;
	(b) position error.
26.74.8	State the serviceability checks for a VSI and IVSI.
26.74.9	Explain the function and operation of the alternate static system.
26.75	**“EFIS” Instrument Displays**

Sub Topic	Syllabus Item
26.75.1	Describe the components and operation of a typical light twin EFIS cockpit display system.
26.75.2	Describe the function of the: (a) air data computer; (b) signal generator; (c) input data sources to a basic glass flight display system.
26.75.3	Describe the components and operation of a Attitude Heading Reference System (AHRS) system.
26.75.4	Describe the management of EFIS system failures.
26.76	**Magnetic Instruments**
26.76.1	Describe the angle of dip and components H and Z of the earth's magnetic flux.
26.76.2	Describe the basic features of a typical aircraft direct-reading magnetic compass, and explain the reason(s) for: (a) pendulous suspension of the magnet system; (b) immersing the magnet system in fluid.
26.76.3	Describe acceleration and turning errors in each hemisphere of a direct-reading compass, and then explain the practical aspects of these errors.
26.76.4	Explain what a compass swing is and give examples of the occasions on which it is required.
26.76.5	Outline the service limits and tolerances for a direct-reading compass.
26.77	**Gyroscopic Instruments**
26.77.1	Distinguish between suction pump, venturi, and positive pressure systems.
26.77.2	Describe the inherent properties of a spinning gyroscope rotor.
26.77.3	Explain what is meant by the term gimbal, and list the types of gyroscope.
26.77.4	With the aid of a diagram, explain the principle of operation of a turn indicator.

Sub Topic	Syllabus Item
26.77.5	Distinguish between a turn indicator (TI) and a turn coordinator (TC).
26.77.6	State the errors which a turn indicator is subject to.
26.77.7	State the principle of operation of the balance ball and, with the aid of diagrams, interpret various TI and TC indications.
26.77.8	Explain the serviceability checks for the TI/TC.
26.77.9	With the aid of a diagram, explain the principle of operation of a heading indicator (HI) or direction indicator (DI).
26.77.10	Explain the following errors which the DI is subject to: (a) gimbal error; (b) real drift (or real wander); (c) apparent drift (or apparent wander); (d) low rotor speed.
26.77.11	State the common operating limitations and serviceability checks for a DI.
26.77.12	Explain the advantages of an electrically-driven DI versus an air-driven instrument.
26.77.13	With the aid of a diagram, explain the principle of operation of an attitude indicator (AI) or artificial horizon (AH).
26.77.14	Describe the effects of a straight-line acceleration and a turn, on the pendulous unit of an air-driven AH, and state the errors in indication arising from these effects.
26.77.15	Describe the general operating limitations of air-driven and electrically-driven AH.
26.77.16	With the aid of diagrams, distinguish between the indications of the TC and AH under various conditions.
26.79	**GNSS Systems**
26.79.1	Describe the function, principle of operation and limitations of a Global Navigation Satellite System (GNSS).

Sub Topic	Syllabus Item
26.79.2	Explain the term RAIM prediction and explain the significance of these predictions.
26.79.3	Explain the term RNP and the significance of the RNP value.
26.80	**TCAS and GPWS Systems**
26.80.1	Describe the function and operation of a typical TCAS system.
26.80.2	Describe the function and operation of a typical GPWS system.
26.82	**Flight Director – Autopilot Systems**
26.82.1	Describe the function and operation of a basic FD-AFCS system.
26.82.2	Describe the typical vertical and lateral operational modes.
26.82.3	Explain the limitations and cautions for the operation of a FD-AFCS system.
26.84	**Oxygen Systems**
26.84.1	Describe the function and principle of operation of a cockpit fitted or portable oxygen system.