Appendix II Subject No 64 Basic Turbine Knowledge

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.

Sub Topic	Syllabus Item
64.2	**Basic Turbine Engine Theory**
64.2.2	Describe Newton’s third law of motion and its practical application as it relates to the operation of a turbine engine.
64.2.4	Describe how gas undergoes changes in pressure, volume and temperature in accordance with Boyle’s and Charles’ Laws.
64.2.6	Describe each of the following and their application to turbine engine operation: (a) Bernoulli’s Theorem; (b) Brayton constant pressure cycle; (c) the pressure-temperature cycle; (d) open and closed cycles; (e) kinetic energy; (f) potential energy; and (g) thermodynamic laws.
64.2.8	Describe the relationship between velocity, pressure and temperature of air at subsonic, transonic and supersonic speeds.
64.2.10	Describe the changes to pressure, temperature and velocity of the gas flow as it passes through each section of a turbine engine.
64.2.12	Describe the changes in the airflow characteristics of velocity, temperature and pressure through a divergent and convergent duct.
64.4	**Turbine Engine Types**
64.4.2	Compare the working cycle of a turbine engine and a piston engine.
64.4.4	Describe the comparative advantages of turbine engines versus piston engines for aircraft propulsion.
64.4.6	Describe the basic constructional arrangements of the following engine types: (a) turbofan; (b) ducted fan (high bypass ratio); (c) prop fan; (d) turbojet;

Sub Topic	Syllabus Item
	(e) turboprop; and
	(f) turbo-shaft.
64.4.8	Describe the operating parameters, propulsive efficiency characteristics and uses of each of the above engines.
64.4.10	Identify engines that fall into either the thrust-producing or torque-producing category.
64.4.12	Describe the following mechanical arrangements of a turbine engine:
	(a) single-entry two stage centrifugal turboprop;
	(b) twin-spool axial flow turboprop;
	(c) single axial flow compressor, free turbine drive turboprop;
	(d) single-spool axial flow turbojet;
	(e) twin-spool by-pass turbojet (low by-pass ratio);
	(f) aft fan turbojet; and
	(g) triple-spool front fan turbojet (high by-pass ratio).
64.6	**Turbine Engine Inlet Systems**
64.6.2	Describe the purpose, construction and principles of operation of the engine inlet duct.
64.6.4	Describe a sub-sonic divergent inlet duct.
64.8	**Turbine Engine Compressors**
64.8.2	Describe the purpose of a compressor in a turbine engine.
64.8.4	Describe the basic principles of operation of centrifugal and axial flow compressors.
64.8.6	Describe the comparative advantages of centrifugal and axial flow compressors.
64.8.8	Describe the merits of combined centrifugal and axial flow compressor combinations in small turbine engines.
64.8.10	State typical compressor pressure ratios for the various types and configuration of turbine engines.
64.8.12	Describe the relationship between compressor ratio and specific fuel consumption.
64.8.14	Describe the compressor arrangements found on the various types of modern turbine engine.
64.8.16	Describe the purpose and function of:
	(a) diffusers;
	(b) impellers;

Sub Topic	Syllabus Item
	(c) inlet guide vanes;
	(d) rotor blades;
	(e) stator blades;
	(f) variable inlet guide vanes;
	(g) variable stator blades;
	(h) rotating stator blades; and
	(i) bleed valves.
64.8.18	Describe the pressure and velocity changes through a centrifugal compressor.
64.8.20	State the reasons and advantages for multiple spool compressors.
64.8.22	Describe speed relationships between compressor sections and how these speeds may vary with changing atmospheric conditions.
64.8.24	For various types of compressor arrangements identify; Ng, N1, N2, and N3 and state whether each is HP or LP.
64.8.26	State the reasons why axial flow compressors have a higher number of stages.
64.8.28	Describe the relationship between pressure, temperature and velocity in an axial flow compressor.
64.8.30	State the reason for the decrease in size and increase in the number of compressor blades towards the rear of an axial flow compressor.
64.8.32	State the reason for the small pressure change per stage in an axial flow compressor.
64.8.34	Describe the purpose of compressor taper.
64.8.36	Describe cycle pressure ratio.
64.8.38	Describe the operation and pressure ratios associated with low, medium and high bypass fans.
64.8.40	Describe typical compression ratios achieved in modern axial flow compressors and the factors that affect compression ratio.
64.8.42	State the conditions that are commonly known to produce compressor stall with particular regard to:
	(a) compressor maintenance;
	(b) blade damage;
	(c) intake damage/restriction;
	(d) engine handling/operation; and
	(e) fuel scheduling.

Sub Topic	Syllabus Item
64.8.44	Describe how the various stall control systems reduce the possibility of compressor stall.
64.8.46	Describe the purpose and operation of the following stall control devices and what engines they may typically be found on variable angle compressor vane systems; (a) variable angle compressor vane systems; (b) variable angle inlet guide vane system; (c) bleed valves; and (d) bleed band.
64.8.48	Describe the effects of a dirty, worn or damaged compressor on SFC and power output.
64.10	**Turbine Engine Combustion Section**
64.10.2	Describe the operation of the combustion chamber.
64.10.4	Describe the constructional features, materials and principles of operation of the following types of combustion chamber: (a) annular; (b) turbo-annular; (c) multiple can; (d) can-annular type; and (e) reverse-flow annular.
64.10.6	State the comparative advantages of each type of combustion chamber.
64.10.8	Describe the purpose, construction and operation of swirl chambers, air shrouds, liners, interconnectors and discharge orifices.
64.10.10	Describe the uses of primary, secondary and tertiary air flow through or around a combustion chamber.
64.10.12	State the percentages of airflow used for cooling and combustion.
64.10.14	Describe how flameout is caused and prevented.
64.12	**Turbine Engine Turbine Section**
64.12.2	State the function of the turbine section.
64.12.4	Describe meaning, the principles of operation and characteristics of the following turbine blade design: (a) impulse; (b) impulse-reaction; and

Sub Topic	Syllabus Item
	(c) reaction.
64.12.6	Describe multi-stage turbines.
64.12.8	Explain the purpose and function of nozzle guide vanes and how the driving force for impulse and impulse reaction turbines is obtained from the gas flow.
64.12.10	Describe the most common type of turbine blade design and give reasons why this type of blade is preferred.
64.12.12	Describe how a turbine blade extracts energy from the gas stream and drives the wheel/disc.
64.12.14	Identify factors that limit the power available from the turbine stage.
64.12.16	Explain the gas flow pattern through nozzle and blade assembly with particular emphasis on static pressure, temperature and velocity.
64.12.18	State the reasons for compressor-turbine matching and how it is achieved.
64.12.20	State why turbine assemblies increase in diameter towards the rear of the engine.
64.12.22	Describe the function of the following turbine assembly components:
	(a) case;
	(b) nozzle;
	(c) shroud ring;
	(d) tip shrouds;
	(e) wheel/disc; and
	(f) air seal.
64.12.24	Describe how turbine blades, discs and nozzles are cooled using bleed air and modern cooling techniques such as film cooling.
64.12.26	Explain how turbine cases are cooled.
64.12.28	Define turbine blade creep and state the causal factors for this condition.
64.14	**Turbine Engine Exhaust Section**
64.14.2	Describe the exhaust gas flow through convergent and divergent passages.
64.14.4	State the purpose, and principles of operation of the following exhaust nozzle types:
	(a) convergent; and
	(b) convergent-divergent.
64.14.6	Describe the noise levels of different types of exhaust system and their means of noise suppression.
64.16	**Thrust Reversers**

Sub Topic	Syllabus Item
64.16.2	Describe thrust reversal.
64.16.4	Explain the purpose of thrust reversal.
64.16.6	Describe the various types of thrust reverser.
64.18	**Turbine Engine Fuel Systems**
64.18.2	Describe the function of the following turbine engine fuel system components: (a) fuel control unit (hydro pneumatic, hydro mechanical and electro-hydro mechanical); (b) fuel filters (HP and LP); (c) fuel heater; (d) governors and limiting devices; and (e) main fuel pumps.
64.18.4	State the ideal fuel/air ratio for a turbine engine.
64.18.6	State the effect of a change in specific gravity with respect to weight of fuel.
64.18.8	State the purpose of water-methanol injection.
64.18.10	Describe the following properties in relation to turbine fuels: (a) specific gravity; (b) fire hazard; and (c) fuel icing.
64.18.12	State the differences between the various types of jet fuel and identify their common usage names.
64.18.14	Describe the purposes of additives in jet fuels and identify which are the most common for modern engine operations.
64.18.16	State the ground handling requirements and the safety precautions to be observed with the use of turbine engine fuels.
64.18.18	Describe the fuel system markings for jet fuels.
64.18.20	Describe the susceptibility of turbine fuels to water contamination over other types of aviation fuels.
64.18.22	Describe methods of fuel system contamination detection and control.
64.20	**Turbine Engine Lubrication Systems**
64.20.2	Describe the basic requirements, arrangements and principles of operation of typical turbine engine lubrication systems.
64.20.4	Compare the different properties/characteristics of oils used in turboprop, turbojet and turbofan engines.

Sub Topic	Syllabus Item
64.20.6	Describe the relationship, function and principles of operation of the following turbine engine lubrication system components: (a) oil cooler; (b) oil-fuel and oil-air heat exchangers; (c) oil filters/screens (pressure and scavenge); (d) oil pumps; (e) oil system chip detectors and magnetic plugs; (f) oil tanks; (g) breather (including centrifugal type) and pressurisation systems; (h) valves (by-pass/check/relief); and (i) oil fed engine anti-ice systems.
64.20.8	State the reason most turbine engines use fuel to cool the oil in preference to air.
64.22	**Turbine Engine Starting; Ignition; Relight; and Shutdown**
64.22.2	Describe why turbine engines require high-energy ignition systems.
64.22.4	Describe the general precautions and checks prior to ground running a turbine engine.
64.22.6	Describe general procedures for starting, ground run-up and shutting down a turbine engine.
64.22.8	Describe what is meant by self-sustaining rpm and how this is achieved.
64.22.10	Describe why it is necessary to accelerate an engine up to sustaining rpm as quickly and uniformly as possible.
64.22.12	Describe the positive cockpit indications of light-up during start.
64.22.14	Describe the indications, effects and remedial actions for the following defects: (a) hung start; (b) too rapid temp rise; (c) hot start; (d) wet start; (e) poor acceleration up to sustainable rpm; (f) over temp; (g) compressor stall during start;

Sub Topic	Syllabus Item
	(h) compressor surge;
	(i) lack of ignition;
	(j) tail pipe fire;
	(k) flameout;
	(l) overspeed;
	(m) over torque; and
	(n) bleed band or bleed valve stuck in the open or closed position.
64.22.16	Describe the conditions under which a low energy ignition system should be turned on.
64.22.18	Describe the requirement and procedures for an engine re-light in the air.
64.24	**Turbine Engine Air Cooling and Sealing**
64.24.2	Describe the requirement for cooling and sealing of engine components.
64.24.4	Describe the uses of low and high pressure air for cooling and sealing.
64.24.6	Describe the types of air and oil seals.
64.26	**Turbine Engine Indicating and Instrumentation**
64.26.2	Describe the basic requirements, methods of operation, and function of the following typical engine instrument systems:
	(a) flow measuring instruments (pressure/volume, fuel and mass air flow sensing types);
	(b) mechanical measuring instruments (engine RPM, torque and vibration);
	(c) pressure measuring instruments (oil and fuel);
	(d) power measurement (EPR, engine turbine discharge pressure or jet pipe pressure);
	(e) horsepower or thrust measurement (torque gauges)
	(f) temperature measuring instruments; and
	(g) turboprop ice warning systems.
64.26.4	Describe the following terms:
	(a) TIT;
	(b) ITT; and
	(c) EGT.
64.26.6	Describe how power loss is indicated on a turbine engine.

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64.28	**Thrust Augmentation**
64.28.2	Describe the requirements for thrust augmentation.
64.28.4	Describe the methods used for thrust augmentation.
64.28.6	Describe how injected fluid increases power output of an engine.
64.30	**Turbine Engine Performance**
64.30.2	Define the following terms and describe the relationship between them, and their application to engine operation: (a) equivalent shaft horsepower; (b) gross thrust; (c) net thrust; (d) resultant thrust; (e) specific fuel consumption (SFC); (f) thrust specific fuel consumption (TSFC); (g) flat rated SHP; (h) full rated SHP; (i) thrust distribution; and (j) thrust horsepower.
64.30.4	Describe the effect of the following factors on turbine engine performance, specifically thrust and fuel flow: (a) airspeed; (b) ram effect; (c) altitude; (d) pressure; (e) temperature; (f) humidity; (g) bleed air; and (h) air intake icing.
64.30.6	List the main factors that limit the power output of turbine engines.
64.30.8	Describe the propulsive efficiency of the following types of turbine engine:

Sub Topic	Syllabus Item
	(a) turboprop;
	(b) high by-pass ratio turbofan;
	(c) low by-pass ratio turbofan; and
	(d) turbojet.
64.30.10	Calculate SFC from given operating conditions.
64.30.12	Describe how specific thrust and SFC will be affected by increasing the compression ratio of an engine.
64.30.14	State the causes of the reduction in SFC with increasing airspeed in turboprop engines.
64.30.16	Identify components in a turbine engine that produce either forward propulsive or rearward propulsive forces.
64.30.18	Describe how the rated thrust of an engine is derived from the calculation of forward and rearward forces.
64.30.20	Describe the approximate power requirements needed to drive the compressor on the various types of engine.
64.30.22	Define giving practical examples:
	(a) by-pass ratio; and
	(b) engine pressure ratio and how/where it is measured.
64.30.24	Describe the effects of bleed air operation on engine performance.
64.32	**Turbine Engine Fire Protection Systems**
64.32.2	Describe the principles, features and parameters of typical fire protection systems.
64.32.4	Describe the operation of unit-type and continuous loop fire detectors.
64.32.6	List the common extinguishing agents and state any precautions when using.
64.32.8	Describe common fire extinguishing systems and the limitations with their use.
64.34	**Turbine Engine Anti-icing Systems**
64.34.2	Describe the principles, features and parameters of typical ice protection systems.
64.34.4	Describe effects of anti-ice system operation on engine performance for the various types of turbine engine and how this would be shown in the cockpit.
64.34.6	Describe the common source of bleed air.