

FOGLALKOZÁSI TERV

Tanítási hetek száma: 14

Előadás: heti 3 óra, félévi: 42 óra
Előadó: Répási-Nagy László

A tantárgy kredit értéke: 3
Gyakorlat: heti 1 óra, félévi 14 óra
Gyak. vez.: Répási-Nagy László

Számonkérés formája: vizsga (kollokvium)

Zárthelyi dolgozatok száma: 2

A megíratás időpontja:

7. és 14. tanulmányi hét

Kötelező és ajánlott szakirodalmak:

- Dr. Szabó Gyula Repülőgép Hajtóművek I. Dugattyús motorok 2007.
- TÁMOP -4.1.2.D-12/1/KONV-2012-0019 „Nyelvtudás” Idegen nyelvi képzési rendszer fejlesztése a Nyíregyházi Főiskolán 2013-2014 Powerplant
- © CAE Oxford Aviation Academy (UK) Limited 2014: Powerplant
- Aviation Maintenance Technician Handbook, Airframe Vol1, Vol2, 2012, ISBN: FAA8083-31
- BRODSZKY D.: Repülőgéphajtóművek I. Budapesti Műszaki Egyetem, Budapest.
- Powerplants, Oxford Aviation Training, Jeppesen, 2008. ISBN: 0884872858
- SZABÓ GY.: Repülőgép hajtóművek II. Főiskola jegyzet, Mezőgazdasági Főiskola, Nyíregyháza, 1985., 1987. ISBN: -
- VASS B.: Repülőgéphajtómű-szerkezetten III. Műszaki Könyvkiadó, Budapest, 1980. ISBN:963103629

A félévelismerés feltételei (címszavakban):

Foglalkozásokon a jelenlét, fegyelmezett viselkedés és aktív munkavégzés a Tanulmányi és Vizsgaszabályzat szerint, valamint használható kézi jegyzet írása az órákon.

Hiányzás max. 3 heti óraszámnak megfelelő óráról.

Vizsgára bocsátás feltétele:

- | | |
|-------------------------|----------|
| - 1. zárthelyi dolgozat | 25 pont |
| - 2. zárthelyi dolgozat | 25 pont |
| - Kollokvium | 50 pont |
| - Összesen | 100 pont |

Mindkét dolgozatnál és a vizsgán legalább elégséges (magasabb mint 50%) szintet kell elérni.

Teach. Week	Lecture	Hrs.	Practice	Hrs.
1.	Piston Engine - General Introduction, Parts of a piston engine	3	Oxford video presentation and ATPL test	1
2.	Piston Engine - Lubrication and Cooling, Ignition	3	Oxford video presentation and ATPL test	1
3.	Piston Engine - Fuel and Mixture	3	Oxford video presentation and ATPL test	1
4.	Piston Engine - Carburettors, Engine Icing and Fuel injection	3	Oxford video presentation and ATPL test	1
5.	Piston Engine - Performance and power augmentation in general, Turbo charger and Supercharger	3	Oxford video presentation and ATPL test	1
6.	Piston Engine - Propellers' characteristics, Propellers in operation	3	Oxford video presentation and ATPL test	1
7.	<i>Progress Test 1. / Retake</i>	3	Retake / Grade Improvement	1
8.	<i>Gas Turbines – Introduction and Air Inlets, Compressors</i>	3	Oxford video presentation and ATPL test	1
9.	<i>Gas Turbines - Combustion Chambers, Turbine Assembly</i>	3	Oxford video presentation and ATPL test	1
10.	<i>Gas Turbines - Exhaust System, Lubrication</i>	3	Oxford video presentation and ATPL test	1
11.	<i>Gas Turbines – Thrust and Reverse Thrust, Gearboxes and Accessory Drives</i>	3	Oxford video presentation and ATPL test	1
12.	<i>Gas Turbines - Ignition Systems, Auxiliary Power Units and Engine Starting</i>	3	Oxford video presentation and ATPL test	1
13.	<i>Gas Turbines – Fuels and Fuel Systems, Bleed Air</i>	3	Oxford video presentation and ATPL test	1
14.	<i>Progress Test 2. / Retake</i>	3	Retake / Grade Improvement	1

021.10.01.01 Types of internal-combustion engines: basic principles, definitions

021.10.01.01.01 Define the following terms and expressions: rpm; torque; manifold absolute pressure (MAP); power output; specific fuel consumption; compression ratio, clearance volume, swept (displaced) volume, total volume.

The Theoretical Otto Cycle

The Operation of the Practical Otto Cycle

021.10.01.02 Engine: design, operation, components

021.10.01.02.01 Describe the basic operating principle of a piston engine: crankcase; crankshaft; connecting rod; piston; piston pin; piston rings; cylinder; cylinder head; valves; valve springs; push rod; camshaft; rocker arm; camshaft gear; bearings.

021.10.01.02.02 Name and identify the various types of engine design with regard to cylinder arrangement and their advantages/disadvantages: horizontally opposed; in line; radial; and working cycle (four stroke: petrol and diesel).

021.10.01.02.03 Describe the differences between petrol and diesel engines with respect to: means of ignition; maximum compression ratio; regulating air or mixture supply to the cylinder; pollution from the exhaust.

021.10.06.00 Lubrication systems

021.10.06.01 Lubricants: characteristics, limitations

021.10.06.01.01 Describe the term 'viscosity' including the effect of temperature.

021.10.06.01.02 Describe the viscosity grade numbering system used in aviation.

021.10.06.02 Design, operation, indications and warnings

021.10.06.02.01 State the functions of a piston-engine lubrication system.

021.10.06.02.02 Describe the working principle of a dry-sump lubrication system and describe the functions of the following components: oil tank (reservoir) and its internal components: hot well, de-aerator, vent, expansion space; check valve (non-return valve); pressure pump and pressure-relief valve; scavenge pump; filters (suction, pressure and scavenge); oil cooler; oil cooler bypass valve (anti-surge and thermostatic); pressure and temperature sensors; lines.

021.10.06.02.03 Describe a wet-sump lubrication system.

021.10.06.02.04 State the differences between a wet- and a dry-sump lubrication system and their advantages and disadvantages.

021.10.06.02.05 List the following factors that influence oil consumption: oil grade; cylinder and piston wear; condition of piston rings.

021.10.06.02.06 Describe the interaction between oil pressure, oil temperature and oil quantity.

021.10.05.00 Cooling systems

021.10.05.01 Design, operation, indications and warnings

021.10.05.01.01 Specify the reasons for cooling a piston engine.

021.10.05.01.02 Describe the design features to enhance cylinder air cooling for aeroplanes.

021.10.05.01.03 Describe the design features to enhance cylinder air cooling for helicopters (e.g. engine-driven impeller and scroll assembly, baffles).

021.10.05.01.04 Compare the differences between liquid- and air-cooling systems.

021.10.05.01.05 Identify the cylinder head temperature indication to monitor engine cooling.

021.10.05.01.06 Describe the function and the operation of cowl flaps.

021.10.07.00 Ignition circuits

021.10.07.01 Design, operation

021.10.07.01.01 Describe the working principle of a magneto-ignition system and the functions of the following components: magneto; contact-breaker points; capacitor (condenser); coils or windings; ignition switches; distributor; spark plug; high-tension (HT) cable.

021.10.07.01.02 State why piston engines are equipped with two electrically independent ignition systems.

021.10.07.01.03 State the function and operating principle of the following methods of spark augmentation: starter vibrator (booster coil); impulse-start coupling.

021.10.07.01.04 State the function and operating principle of the following methods of spark augmentation: starter vibrator (booster coil); both magnetos live.

021.10.07.01.05 Explain the function of the magneto check.

021.10.07.01.06 Explain how combustion is initiated in diesel engines.

021.10.02.00 Fuel

021.10.02.01 Types, grades, characteristics, limitations

021.10.02.01.01 Name the type of fuel used for petrol engines including its colour (AVGAS); 100 (green); 100LL (blue).

021.10.02.01.02 Name the type of fuel normally used for aviation diesel engines (JET-A1).

021.10.02.01.03 Define the term 'octane rating'.

021.10.02.01.04 Define the term 'detonation' and describe the causes and effects of detonation for both petrol and diesel engines.

021.10.02.01.05 Define the term 'pre-ignition' and describe the causes and effects of pre-ignition for both petrol and diesel engines.

021.10.02.01.06 Identify the conditions and power settings that promote detonation for petrol engines.

021.10.02.01.07 Describe how detonation in petrol engines is recognised.

021.10.02.01.08 Describe the method and occasions for checking the fuel for water content.

021.10.02.01.09 State the typical value of fuel density for aviation gasoline and diesel fuel.

021.10.02.01.10 Explain volatility, viscosity and vapour locking for petrol and diesel fuels.

021.10.03.00 Engine fuel pumps

021.10.03.01 Engine-driven fuel pump

021.10.03.01.01 Explain the need for a separate engine-driven fuel pump.

021.10.04.00 Carburettor/injection system

021.10.04.01 Carburettor: design, operation, degraded modes of operation, indications and warnings

021.10.04.01.01 State the purpose of a carburettor.

021.10.04.01.02 Describe the operating principle of the simple float chamber carburettor.

021.10.04.01.03 Describe the methods of obtaining mixture control over the whole operating engine power setting range (compensation jet, diffuser).

021.10.04.01.04 Describe the methods of obtaining mixture control over the whole operating altitude range.

021.10.04.01.05 Explain the purpose and the operating principle of an accelerator pump.

021.10.04.01.06 Explain the purpose of power enrichment.

021.10.04.01.07 Describe the function of the carburettor heat system.

021.10.04.01.08 Explain the effect of carburettor heat on mixture ratio and power output.

021.10.04.01.09 Explain the purpose and the operating principle of a primer pump.

021.10.04.01.10 Discuss other methods for priming an engine (acceleration pumps).

021.10.04.01.11 Explain the danger of carburettor fire, including corrective measures.

021.10.04.02 Injection: design, operation, degraded modes of operation, indications and warnings

021.10.04.02.01 Explain the advantages and difference in operation of an injection system compared with a carburettor system.

021.10.04.03 Icing

021.10.04.03.01 Describe the causes and effects of carburettor icing and the action to be taken if carburettor icing is suspected.

021.10.04.03.02 Name the meteorological conditions under which carburettor icing may occur.

021.10.04.03.03 Describe the indications of the presence of carburettor icing for both a fixed pitch and a constant speed propeller.

021.10.04.03.04 Describe the indications of the presence of carburettor icing for a helicopter.

021.10.04.03.05 Describe the indications that will occur upon selection of carburettor heat depending on whether ice is present or not.

021.10.04.03.06 Explain the reason for the use of alternate air on fuel injection systems and describe its operating principle.

021.10.04.03.07 State the meteorological conditions under which induction system icing may occur.

021.10.08.00 Mixture

021.10.08.01 Definition, characteristic mixtures, control instruments, associated control levers, indications

021.10.08.01.01 Define the following terms: mixture; chemically correct ratio (stoichiometric); best power ratio; lean (weak) mixture (lean or rich side of the exhaust gas temperature (EGT) top); rich mixture.

021.10.08.01.02 State the typical fuel-to-air ratio values or range of values for the above mixtures.

021.10.08.01.03 Describe the advantages and disadvantages of weak and rich mixtures.

021.10.08.01.04 Describe the relation between engine-specific fuel consumption and mixture ratio.

021.10.08.01.05 Describe the use of the exhaust gas temperature as an aid to mixture-setting.

021.10.08.01.06 Explain the relation between mixture ratio, cylinder head temperature, detonation and pre-ignition.

021.10.08.01.07 Explain the absence of mixture control in diesel engines.

021.10.10 00 Performance and engine handling

021.10.10.01 Performance

021.10.10.01.01 Describe the effect on power output of a petrol and diesel engine taking into consideration the following parameters: ambient pressure, exhaust back pressure; temperature; density altitude; humidity.

021.10.10.01.02 Explain the term 'normally aspirated engine'.

021.10.10.01.03 Power-augmentation devices: explain the requirement for power augmentation (turbocharging) of a piston engine.

021.10.10.01.04 Describe the function and the principle of operation of the following main components of a turbocharger: turbine; compressor; waste gate; waste-gate actuator.

021.10.10.01.05 Explain the difference between an altitude-boosted turbocharger and a ground-boosted turbocharger.

021.10.10.01.06 Explain turbo lag.

021.10.10.01.07 Define the term 'critical altitude'.

021.10.10.01.08 Explain the function of an intercooler.

021.10.10.01.09 Define the terms 'full-throttle height' and 'rated altitude'.

021.10.10.01.10 Explain the purpose of a supercharger and the basic differences from a turbocharger.

021.10.10.02 Engine handling

021.10.10.02.01 State the correct procedures for setting the engine controls when increasing or decreasing power.

021.10.10.02.02 Define the following terms: take-off power; maximum continuous power.

021.10.10.02.03 Describe the start problems associated with extreme cold weather.

021.10.10.02.04 Describe the principal difference between a full-authority digital engine control (FADEC) system-controlled engine and traditional manual engine controls.

021.10.10.02.05 Describe the engine controls available on the flight deck for a FADEC-controlled engine.

021.10.10.02.06 Explain that the FADEC has full authority of the control of all engine parameters ensuring efficient and correct running of the engine, including protection in the event of failure.

021.10.10.02.07 Explain the need for FADEC redundancy with regard to power supply and data input and output.

021.10.09.00 Aeroplane: propellers

021.10.09.01 Definitions, general Remark: Definitions and aerodynamic concepts are detailed in Subject 081 'Principles of flight (aeroplane)', Topic 07 (Propellers), but need to be appreciated for this Subject as well.

021.10.09.02 Constant-speed propeller: design, operation, system components

021.10.09.02.01 Describe the operating principle of a constant-speed propeller system under normal flight operations with the aid of a schematic.

021.10.09.02.02 Explain the need for a MAP indicator to control the power setting with a constant-speed propeller.

021.10.09.02.03 State the purpose of a torque-meter.

021.10.09.02.04 State the purpose and describe the operation of a low-pitch stop (centrifugal latch).

021.10.09.02.05 Describe the operating principle of a single-acting and a double-acting variable pitch propeller for single- and multi-engine aeroplanes.

021.10.09.02.06 Describe the function and the basic operating principle of synchronising and synchrophasing systems.

021.10.09.02.07 Explain the purpose and the basic operating principle of an auto-feathering system and unfeathering.

021.10.09.03 Reduction gearing: design

021.10.09.03.01 State the purpose of reduction gearing.

021.10.09.04 Propeller handling: associated control levers, degraded modes of operation, indications and warnings

021.10.09.04.01 Describe the checks to be carried out on a constant-speed propeller system after engine start.

021.10.09.04.02 Describe the operation of a constant-speed propeller system during flight at different true airspeeds (TAS) and rpm including an overspeeding propeller.

021.10.09.04.03 Describe the operating principle of a variable pitch propeller when feathering and unfeathering, including the operation of cockpit controls.

021.10.09.04.04 Describe the operating principle of a variable pitch propeller when reverse pitch is selected, including the operation of cockpit controls.

021.10.09.04.05 Describe the operation of the propeller levers during different phases of flight.

TURBINE ENGINES

Basic principles

Basic generation of thrust and the thrust formula

Describe how thrust is produced by a basic gas turbine engine.

Describe the simple form of the thrust formula for a basic, straight jet engine and perform simple calculations (including pressure thrust).

State that thrust can be considered to remain approximately constant over the whole aeroplane subsonic speed range.

Design, types and components of turbine engines

List the main components of a basic gas turbine engine: inlet; compressor; combustion chamber; turbine; outlet.

Describe the variation of static pressure, temperature and axial velocity in a gas turbine engine under normal operating conditions and with the aid of a working cycle diagram.

Describe the differences between absolute, circumferential (tangential) and axial velocity.

List the different types of gas turbine engines: straight jet; turbofan; turboprop.

State that a gas turbine engine can have one or more spools.

Describe how thrust is produced by turbojet and turbofan engines.

Describe how power is produced by turboprop engines.

Describe the term 'equivalent horsepower' (= thrust horsepower + shaft horsepower).

Explain the principle of a free turbine or free-power turbine.

Define the term 'bypass ratio' and perform simple calculations to determine it.

Define the terms 'propulsive power', 'propulsive efficiency', 'thermal efficiency' and 'total efficiency'.

Describe the influence of compressor-pressure ratio on thermal efficiency.

Explain the variations of propulsive efficiency with forward speed for turbojet, turbofan and turboprop engines.

Define the term 'specific fuel consumption' for turbojets and turboprops.

Coupled turbine engine: design, operation, components and materials

Name the main assembly parts of a coupled turbine engine and explain its operation.

Explain the limitations of the materials used with regard to maximum turbine temperature, engine and drive train torque limits.

Describe the possible effects on engine components when limits are exceeded.

Explain that when engine limits are exceeded, this event must be reported.

Free-turbine engine: design, components and materials

Describe the design methods to keep the engine's size small for installation in helicopters.

List the main components of a free-turbine engine.

Describe how the power is developed by a turboshaft/free-turbine engine.

Explain how the exhaust gas temperature is used to monitor turbine stress.

Main-engine components

Aeroplane: air intake

State the functions of the engine air inlet/air intake.

Describe the geometry of a subsonic (pitot-type) air inlet.

Explain the gas-parameter changes in a subsonic air inlet at different flight speeds.

Describe the reasons for, and the dangers of, the following operational problems concerning the engine air inlet: airflow separation; inlet icing; inlet damage; foreign object damage (FOD); heavy in-flight turbulence.

Compressor and diffuser

State the purpose of the compressor.

Describe the working principle of a centrifugal and an axial flow compressor.

Name the following main components of a single stage and describe their function for a centrifugal compressor: impeller; diffuser.

Name the following main components of a single stage and describe their function for an axial compressor: rotor vanes; stator vanes.

Describe the gas-parameter changes in a compressor stage.

Define the term 'pressure ratio' and state a typical value for one stage of a centrifugal and an axial flow compressor and for the complete compressor.

State the advantages and disadvantages of increasing the number of stages in a centrifugal compressor.

Explain the difference in sensitivity for FOD of a centrifugal compressor compared with an axial flow type.

Explain the convergent air annulus through an axial flow compressor.

Describe the reason for twisting the compressor blades.

State the tasks of inlet guide vanes (IGVs).

State the reason for the clicking noise whilst the compressor slowly rotates on the ground.

State the advantages of increasing the number of spools.

Explain the implications of tip losses and describe the design features to minimise the problem.

Explain the problems of blade bending and flapping and describe the design features to minimise the problem.

Explain the following terms: compressor stall; engine surge.

State the conditions that are possible causes of stall and surge.

Describe the indications of stall and surge.

Describe the design features used to minimise the occurrence of stall and surge.

Describe a compressor map (surge envelope) with rpm lines, stall limit, steady state line and acceleration line.

Describe the function of the diffuser.

Combustion chamber

Define the purpose of the combustion chamber.

List the requirements for combustion.

Describe the working principle of a combustion chamber.

Explain the reason for reducing the airflow axial velocity at the combustion chamber inlet (snout).

State the function of the swirl vanes (swirler).

State the function of the drain valves.

Define the terms 'primary airflow' and 'secondary airflow', and explain their purpose.

Explain the following two mixture ratios: primary airflow to fuel; total airflow (within the combustion chamber) to fuel.

Describe the gas-parameter changes in the combustion chamber.

State a typical maximum value of the outlet temperature of the combustion chamber.

Describe the following types of combustion chambers and state the differences between them: can type; can-annular, cannular or turbo-annular; annular; reverse-flow annular.

Turbine

Explain the purpose of a turbine in different types of gas turbine engines.

Describe the principles of operation of impulse, reaction and impulse-reaction axial flow turbines.

Name the main components of a turbine stage and their function.

Describe the working principle of a turbine.

Describe the gas-parameter changes in a turbine stage.

Describe the function and the working principle of active clearance control.

Describe the implications of tip losses and the means to minimise them.

Explain why the available engine thrust is limited by the turbine inlet temperature.

Explain the divergent gas-flow annulus through an axial-flow turbine.

Explain the high mechanical thermal stress in the turbine blades and wheels/discs.

Aeroplane: exhaust

Name the following main components of the exhaust unit and their function: jet pipe; propelling nozzle; exhaust cone.

Describe the working principle of the exhaust unit.

Describe the gas-parameter changes in the exhaust unit.

Define the term 'choked exhaust nozzle' (not applicable to turboprops).

Explain how jet exhaust noise can be reduced.

Additional components and systems

Engine fuel system

Name the main components of the engine fuel system and state their function: filters; low-pressure (LP) pump; high-pressure (HP) pump; fuel manifold; fuel nozzles; HP fuel cock; fuel control; or hydromechanical unit.

Name the two types of engine-driven high-pressure pumps, such as: gear-type; swash plate-type.

State the tasks of the fuel control unit.

List the possible input parameters to a fuel control unit to achieve a given thrust/power setting.

Engine control system

State the tasks of the engine control system.

List the following different types of engine control systems: hydromechanical; hydromechanical with a limited authority electronic supervisor; single-channel FADEC with hydromechanical backup; dual-channel FADEC with no backup or any other combination.

Describe a FADEC as a full-authority dual-channel system including functions such as an electronic engine control unit, wiring, sensors, variable vanes, active clearance control, bleed configuration, electrical signalling of thrust lever angle (TLA) (see also AMC to CS-E-50), and an EGT protection function and engine overspeed.

Explain how redundancy is achieved by using more than one channel in a FADEC system.

State the consequences of a FADEC single input data failure.

State that all input and output data is checked by both channels in a FADEC system.

State that a FADEC system uses its own sensors and that, in some cases, also data from aircraft systems is used.

State that a FADEC must have its own source of electrical power.

Engine lubrication

State the tasks of an engine lubrication system.

Name the following main components of a lubrication system and state their function: oil tank and centrifugal breather; oil pumps (pressure and scavenge pumps); oil filters (including the bypass); oil sumps; chip detectors; coolers.

Explain that each spool is fitted with at least one ball bearing and two or more roller bearings.

Explain the use of compressor air in oil-sealing systems (e.g. labyrinth seals).

Engine auxiliary gearbox

State the tasks of the auxiliary gearbox.

Describe how the gearbox is driven and lubricated.

Engine ignition

State the task of the ignition system.

Name the following main components of the ignition system and state their function: power sources; igniters.

State why jet turbine engines are equipped with two electrically independent ignition systems.

Explain the different modes of operation of the ignition system.

Engine starter

Name the main components of the starting system and state their function.

Explain the principle of a turbine engine start.

Describe the following two types of starters: electric; pneumatic.

Describe a typical start sequence (on ground/in flight) for a turbofan.

Define 'self-sustaining rpm'.

Reverse thrust

Name the following main components of a reverse-thrust system and state their function: reverse-thrust select lever; power source (pneumatic or hydraulic); actuators; doors; annunciations.

Explain the principle of a reverse-thrust system.

Identify the advantages and disadvantages of using reverse thrust.

Describe and explain the following different types of thrust-reverser systems: hot-stream reverser; clamshell or bucket-door system; cold-stream reverser (only turbofan engines); blocker doors; cascade vanes.

Explain the implications of reversing the cold stream (fan reverser) only on a high bypass ratio engine.

Describe the protection features against inadvertent thrust-reverse deployment in flight as present on most transport aeroplanes.

Describe the controls and indications provided for the thrust-reverser system.

Engine operation and monitoring

General

Explain the following aeroplane engine ratings: take-off; go-around; maximum continuous thrust/power; maximum climb thrust/power.

Explain spool-up time.

Explain the reason for the difference between ground and approach flight idle values (rpm).

State the parameters that can be used for setting and monitoring the thrust/power.

Describe the terms 'alpha range', 'beta range' and 'reverse thrust' as applied to a turboprop power lever.

Explain the dangers of inadvertent beta-range selection in flight for a turboprop.

Explain the purpose of engine trending.

Explain how the exhaust gas temperature is used to monitor turbine stress.

Describe the effect of engine acceleration and deceleration on the EGT.

Describe the possible effects on engine components when EGT limits are exceeded.

Explain why engine-limit exceedances must be reported.

Explain the limitations on the use of the thrust-reverser system at low forward speed.

Explain the term 'engine seizure'.

State the possible causes of engine seizure and explain their preventative measures.

Describe the potential consequences of a leak in the following two designs of fuel and oil heat exchanger: oil pressure higher than fuel pressure with oil leaking into the fuel system, potentially affecting the combustion and running of the engine; fuel pressure higher than oil pressure with fuel leaking into the oil system, potentially increasing the risk of a fire due to fuel entering warm parts of the engine that should be free from fuel.

Explain oil-filter clogging (blockage) and the implications for the lubrication system.

Give examples of monitoring instruments of an engine.

Describe how to identify and assess engine damage based on instrument indications.

Starting malfunctions

Describe the indications and the possible causes of the following aeroplane starting malfunctions: false (dry or wet) start; tailpipe fire (torching); hot start; abortive (hung) start; no N1 rotation; no FADEC indications.

Describe the indications and the possible causes of the following helicopter starting malfunctions: false (dry or wet) start; tailpipe fire (torching); hot start; abortive (hung) start; no N1 rotation; freewheel failure; no FADEC indications.

Relight envelope

Explain the relight envelope.

Performance aspects

Thrust, performance aspects, and limitations

Describe the variation of thrust and specific fuel consumption with altitude at constant TAS.

Describe the variation of thrust and specific fuel consumption with TAS at constant altitude.

Explain the term 'flat-rated engine' by describing the change of take-off thrust, turbine inlet temperature and engine rpm with outside air temperature (OAT).

Define the term 'engine pressure ratio' (EPR).

Explain the use of reduced (flexible) and derated thrust for take-off, and explain the advantages and disadvantages when compared with a full-rated take-off.

Describe the effects of use of bleed air on rpm, EGT, thrust, and specific fuel consumption.

Helicopter engine ratings, engine performance and limitations, engine handling: torque, performance aspects and limitations

Describe engine rating torque limits for take-off, transient and maximum continuous.

Describe turbine outlet temperature (TOT) limits for take-off.

Explain why TOT is a limiting factor for helicopter performance.

Describe and explain the relationship between maximum torque available and density altitude, which leads to decreasing torque available with the increase of density altitude.

Explain that hovering downwind, on some helicopters, will noticeably increase the engine TOT.

Explain the reason why the engine performance is less when aircraft accessories (i.e. anti-ice, heating, hoist, filters) are switched on.

Describe the effects of use of bleed air on engine parameters.

Explain that, on some helicopters, exceeding the TOT limit may cause the main rotor to droop (slow down).

Describe overtorquing and explain the consequences.

Auxiliary power unit (APU)

Design, operation, functions, operational limitations

State that an APU is a gas turbine engine and list its tasks.

State the difference between the two types of APU inlets.

Define 'maximum operating and maximum starting altitude'.

Name the typical APU control and monitoring instruments.

Describe the APU's automatic shutdown protection.