021

AIRFRAMES & SYSTEMS, ELECTRICS, POWERPLANT, EMERGENCY EQUIPMENT

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
020 00 00 00	**AIRCRAFT GENERAL KNOWLEDGE**	
021 00 00 00	**AIRFRAME AND SYSTEMS, ELECTRICS, POWERPLANT, EMERGENCY EQUIPMENT - AEROPLANES**	
021 01 00 00	**AIRFRAME AND SYSTEMS**	

021 01 01 00	**Fuselage**
	– List the purposes of the fuselage of a civil air transport aircraft.
	– Describe the different types of fuselage construction.
	– Identify the following structural components in a schematic drawing of a fuselage:
	  – frames
	  – stiffeners, stringers
	  – skin, doublers
	– Describe the sandwich construction method.
	– List the attachment methods in an aircraft construction.
	– List materials used in the fuselage structure and state their characteristics..
	– Compare the relationship between stiffness, strength and weight of the materials used.
	– Describe the basic stresses present in all airframe components.
	– List the typical stresses in the fuselage.
	– State the type of damage possible due to a heavy landing.
	– Name the structural safety factors and their relationship to each other.
	– State that airframe life is limited by fatigue, created by the load cycles during take-off, landing, pressurisation.
	– Describe the following load path philosophies used in airframes:	

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	– safe-life – fail-safe – damage-tolerant – Define the term ‘station numbers’.	
021 01 02 00	**Cockpit and cabin windows**	
	– Describe the types of construction and the materials used for the flight deck windows. – List the typical loads of cockpit windows. – State that certain vertical and horizontal angles are specified for visibility. – Describe the operating principle of cockpit window heating.	
021 01 03 00	**Wing**	
	– Describe the different types of wing construction. – List the main structural components of a wing and their function. – List materials used in the wings. – Describe the wing loads on ground and in flight. – Describe the effect of engine position, fuel tank position, and fuel quantity and distribution on stress relief and wing flutter characteristics. – Define the maximum zero-fuel weight (MZFW).	
021 01 04 00	**Stabilising surfaces**	
	– Identify the different empennage configurations. – List the functions of the horizontal and vertical elements of the empennage. – Identify and explain the loads in the horizontal and vertical elements.	

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	– List materials used in empennage surfaces. – Explain the factors involved in flutter of control surfaces and the structures to which they are attached.	

021 01 05 00	**Landing gear**
	- Name the types and layouts of landing gears.
	- List the advantages of a tricycle landing gear during ground operations.
	- List the main components of the landing gear and describe their function.
	  - oleo leg/shock strut
	  - axles
	  - bogies
	  - drag struts
	  - side stays/struts
	  - torsion links (scissors)
	  - locks
	  - gear doors and retraction mechanisms
	- Identify landing gear components with the aid of a simple schematic drawing.
	- Describe the various indications and warnings of typical landing gear systems.
	- Describe typical gear warning systems and explain their operating principles.
	- Describe the protection device to avoid gear retraction on ground.
	- Describe the shape of the landing gear lever.
	- Describe various methods for emergency gear extension.
	- Explain the operating principle of nose-wheel steering.
	- Describe the different tyre-types and constructions.	

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	- Define the term 'ply rating'. - Describe material and basic construction of the rim of an aircraft wheel. - Explain the function of thermal plugs. - Define the term 'tyre tread' and explain the advantages and disadvantages of various tread patterns. - Define the term 'tyre creep'. - Define the term 'shimmy' of the nosewheel. - Define the terms 'hydroplaning' and 'hydroplaning' speed in relation to the tyre pressure. - List typical tyre pressure values for transport aircraft and describe their possible indication in the cockpit. - Identify the wheel temperature indication in the cockpit of some aircraft. - State that the ground speed of the tyres is limited. - List types of brakes and describe their basic operating principle. - Explain the function of wear indicators. - Explain how the brakes are actuated. - Identify the task of an autoretract brake system. - State the limitation of the brake energy capacity and describe the constructional and operational consequences - Describe the anti-skid system: advantages operating principle - Describe the auto-brake system: advantages operating principle	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	operation	
021 01 06 00	**Flight controls (construction and operation)**	
021 01 06 01	**Primary controls**	
	- List the different primary flight control surfaces and describe their operating principle. - Explain the methods of locking the controls on the ground and describe “control lock“ warnings. - Describe the various primary control surface actuation methods and compare them. - Explain how redundancy is obtained in primary flight control systems of transport aircraft. - Describe different types of position indicators of flight controls of transport aircraft. - State the need for ‘feel systems’ in hydraulic actuated flight controls. - State that the pilots control loads are limited by airworthiness requirements. - Describe the purpose of a trim system. - List the different types of trim device. - Describe different types of trim controls and indicators. - List different types of aerodynamic balance devices and explain their purpose and principle of operation.	
021 01 06 02	**Secondary controls, lift augmentation and wing flaps**	
	- List secondary flight controls, explain their functions and describe their mode of operation. - Explain the operating principle of an automatic speed brake system. - Describe the load limiting protection devices on some trailing edge flaps systems. - Describe various secondary flight control actuation methods and sources of actuating power. - Describe various secondary flight control selectors and indicators. - Describe configuration warnings and explain potential dangers.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
021 01 07 00	**Hydraulics**	
021 01 07 01	**Basic principles of Hydromechanics**	
	- List and explain the properties of the ideal hydraulic fluid.	
	- Name the types of hydraulic fluids in use in aircraft hydraulic systems, specify their characteristics, advantages and disadvantages and name their use.	

	- Explain the working principle of
	  - hydraulic systems in general.
	  - a passive hydraulic system without pressure pump.
	  - an active hydraulic system with pressure pump.	

	- State the main advantages and disadvantages of hydraulic systems.	Given a schematic drawing of a passive hydraulic system.
	- List the main users of hydraulic systems.	
	- Identify the main components of passive systems and describe their function.	
	- Explain how to identify a fuel leak in a hydraulic system.	

	- Identify the main components of active systems and describe their working principles and functions
	  - reservoir
	  - accumulators
	  - pumps from various power sources
	  - engine driven
	  - electric
	  - pneumatic
	  - hydraulic (power transfer unit)
	  - case drain lines and fluid cooler
		Given a schematic drawing of an active hydraulic system

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- pressure lines - return lines - actuators - hydraulic motors - check valves, relief valves - restrictor valves - selector valves - by-pass valves - shuttle valves - fire shut-off valves - priority valves	
021 01 07 02	**Hydraulic systems** - Describe the main principles of operation of aircraft hydraulic systems for small and for large aircraft. - State the normal hydraulic system pressure of transport aircraft. - Describe the operating principle of the hydraulic pumps in transport aircraft. - Explain how redundancy is obtained in the hydraulic systems of transport aircraft - Explain the operating principle of the ram air turbine (RAT). - List and describe the types of driving units. - List and describe the types of piston actuators that can be used. - List and describe the instruments for monitoring the hydraulic system, and explain the implications of abnormal indications. - Describe the switching options of hydraulic systems by means of the pump switches.	

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	- Describe the warnings concerning a hydraulic system.	
021 01 08 00	**Air Driven systems (piston engines only)**	
021 01 08 01	**Pneumatic systems**	
	- Identify main components and describe their working principle and function. - List the power sources for pneumatic systems. - Identify the aircraft systems which use compressed air as a power source. - State that in some aircraft the pneumatic air is pre-cooled by an air-to-air heat exchanger. - Identify and describe the purpose of cockpit indicators for pneumatic systems.	
021 01 08 02	**Air-conditioning system**	
	- Identify main components and describe their working principle and function. - Identify heating sources and describe their operating principles. - Identify cooling sources, state how they are used in the aircraft, and describe their operating principles. - Explain how the cabin temperature is controlled. - List and describe the controls and indications for the air-conditioning system.	
021 01 08 03	**Pressurization**	

	– Identify main components and describe their working principle and function.
	– Define the following terms:
	  – cabin altitude
	  – cabin vertical speed
	  – differential pressure
	– State the maximum cabin altitude under normal conditions.	

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	– Explain how the maximum differential pressure limits the maximum operating altitude. – Identify the pressurized areas of a fuselage. – Explain the principle of operation of the cabin pressure-altitude control system. – Describe the operation of the automatic, semi automatic and manual pressurization system. – Explain how the pressurization system is monitored. – Identify and explain the principle of operation of the safety devices in pressurization system. – Explain the reason for the warning placard which is displayed when the aircraft structure is not designed to absorb the landing shock simultaneously with pressure differential forces. – State where the appropriate emergency procedures can be found in the event of rapid decompression.	
021 01 08 04	**De-ice systems**	
	– Identify the location of pneumatic de-ice systems. – Name the categories of aeroplanes where these systems are installed. – Describe the working principle of the inflatable rubber boots. – State how the inflation and deflation is controlled. – Explain when the system should be operated. – State how the system is controlled and monitored.	
021 01 09 00	**Air driven systems (turbopropeller and jet aircraft)**	
021 01 09 01	**Pneumatic system**	
	– List the power sources which drive pneumatic systems. – Describe the purpose of the pneumatic system and list the other aircraft systems for which it is a power source. – Identify the components that constitute the pneumatic system and explain their function.	Given a schematic drawing of the pneumatic system

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– pneumatic ducts – isolation valve – pressure regulating valve – engine bleed valve – start valve – fan air pre-cooler – State how the pneumatic system is controlled and monitored. – Describe the two types of pneumatic duct failure that may occur. – Interpret the thermal sensor indications with regard to their location.	
021 01 09 02	**Air conditioning system** – Describe the purposes of an air-conditioning system. – Explain how air temperature is controlled – Identify the components that constitute an air-conditioning system and describe their operating principles and function: – air cycle machine (pack, bootstrap system) – pack cooling fan – water separator – mixing valves – flow control valves – isolation valves – ram air valve	Given a schematic drawing on an air conditioning system

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– re-circulation fans – filters for re-circulated air – temperature sensors – Describe the use of hot trim air. – List and describe the controls, indications and warnings related to the air-conditioning system. – Describe the purpose of the pressurization system. – Identify the components that constitute the pressurization system: - pneumatic system as the power source - outflow valve - outflow valve actuator - pressure controller - excessive differential pressure relief valve - negative differential pressure relief valve - Define the following terms: - cabin altitude - cabin vertical speed - differential pressure - ground pressurization - Describe the operating principle of the pressurization system. - Describe the emergency operation by manual setting of the outflow valve position. – Identify the protection against structural floor overload as a result of pressure difference.	Given a schematic drawing of a pressurization system

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Describe the working principle of an electronic cabin pressure controller. – State how the maximum operating altitude is determined. - Identify the aural warning when cabin altitude exceeds 10,000 ft. - List the indications of the pressurization system. - State the JAR-OPS requirements for pressurization systems.	
021 01 09 03	**Anti-ice systems**	

	- Explain the difference between de-icing and anti-icing.
	- Describe when anti-ice systems have to be switched on.
	- Name the components of an aircraft that are protected from ice accretion by the use of bleed air.
	- Identify the components which constitute the anti-ice system and describe their function:
	  - pneumatic source
	  - shut-off valves
	  - pneumatic ducts
	  - perforated pneumatic ducts
	  - outflow holes under the wings or into the nacelles
	- Describe the operating principle of the anti-ice system.
	- Describe the two different operating principles of ice detectors.
	- Identify the monitoring instruments and controls of the anti-ice systems.
		Given a schematic drawing of a anti-ice system.

021 01 10 00	**<u>Non-pneumatic operated de-ice and anti-ice systems</u>**	
021 01 10 01	**Schematic construction, function and operation**	
	- Describe the construction, the operating principle and the operation of electric anti-icing of a propeller.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- List other electrically ice protected aircraft components and describe their operation. - Explain the operating principle of the weeping wing system. - Explain the principle and method of operation of windshield rain protecting systems.	
021 01 11 00	**Fuel system**	
021 01 11 01	**Fuel tanks**	

	- List the different types of fuel tanks, describe their construction and state their advantages.
	- Indicate typical tank locations on aircraft and state their advantages.
	- Identify the components of the fuel tank system and explain their function:
	  - tanks
	  - baffles
	  - vent system
	  - overpressure relief valve
	  - surge vent tank
	  - refuel adapter and panel
	  - automatic top-off unit
	- Explain the refueling sequence for tanks which are to be only partially filled.
	- Describe the location and the purpose of the drains.
	- Define the term ‘unusable fuel’.
	- Describe the various methods of refueling.
	- Describe precautions to be observed before refueling.	

021 01 11 02	**Fuel feed**	
	- Describe the methods of fuel feed to the engines and indicate their use.	

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	- Identify the components of a fuel system and describe their operating principle and function:
	  - tank system
	  - fuel lines
	  - selector valves
	  - check valves
	  - screens
	  - fire shut-off valves
	  - fill shut-off valves
	  - cross-feed valve
	- Describe the monitoring instruments and controls of the fuel system.	

021 01 11 03	**Fuel dumping system** - Describe the operating principle of a fuel dump system. - Name the requirements for the minimum fuel remaining. - State which aircraft have fuel dumping systems.	
021 01 11 04	**Fuel system monitoring** - Explain the fuel management system and its operation during flight. - Describe system management by cross-feed valve operation and fuel pump selection. - Describe the method used to indicate fuel quantity. - State that in case of low fuel pressure (e.g. pump off) a warning light illuminates.	

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	- Describe the method of fuel temperature measurement and control, and its limits, related to fuel type. - Describe the use and purpose of dip-sticks	
021 02 00 00	**ELECTRICS**	
021 02 01 00	**Direct current (DC)**	
021 02 01 01	**General**	
	– Electric circuits	
	– Name examples of conductors, semiconductors and insulators.	
	– State the relationship between voltage, current and resistance in a closed electrical circuit.	
	– Name different types of switches.	
	– State the purpose of the guard cap in the case of toggle switches.	
	– State how the following devices work: thermo-, bimetallic-, time- and proximity-switches.	
	– Voltage, current, resistance	
	– Define voltage in words and state the relevant unit of measurement.	
	– Define current in words and state the relevant unit of measurement.	
	– Ohm's law	
	– State Ohm's Law in qualitative terms.	
	– Calculate voltage, current and resistance using Ohm's Law.	
	– Resistive circuits	
	– Calculate the total value of resistance in series and parallel circuits	
	– Explain the relationship between individual voltages and current when resistors are connected in series.	

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	– Explain the relationship between individual currents and voltage when resistors are connected in parallel. – Resistance as a function of temperature – Define the change of resistance of a material as a function of temperature – State that resistances can have a positive temperature coefficient (PTC) or a negative temperature coefficient (NTC) – State that PTC and NTC resistors are used in aircraft systems for temperature measurement – Electrical power, electrical work – Define electrical power in qualitative terms and name the relevant unit of measurement – Define electrical work in qualitative terms and name the relevant unit of measurement. – Fuses, circuit breaker (function, type and operation) – Describe the method of operation of the circuit-breaker. – Explain how a fuse is rated – State the difference between a ”trip-free” and ”non-trip-free” circuit breaker. – State the methods of detecting failures in fuses and circuit-breakers. – List the different types of circuit breakers. – The electrical field – Define the term ”electrical field” in qualitative terms – State the difference between an electrical field and a magnetic field. – The capacitor (function) – State the principle of construction of a capacitor. – State how the capacitance (of a capacitor) is related to the plate area, the distance between the	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	plates ,and the dielectric constant. – State, in qualitative terms, the alteration in total capacitance of capacitors when connected in series or in parallel.	
021 02 01 02	**Batteries**	
	– Types, characteristics	
	– State the components of a battery	
	– Name the types of rechargeable batteries used in aircraft	
	– For lead acid & NiCd batteries	
	– describe the processes which occur during charging and discharging	
	– differentiate between cell voltage and charging voltage	
	– state the effect of temperature.	
	– State the charging voltages which corresponds with different battery voltages.	
	– Compare lead-acid and NiCd batteries in respect of voltage, load behaviour, self-discharge, thermal runaway and storage life	
	– Capacity	
	– Define the term ”capacity of batteries”.	
	– State the relationship between voltage and capacity when batteries are connected in series or in parallel	
	– Uses	
	– List the uses of lead acid batteries and NiCd batteries.	
	– Compare the relative advantages and disadvantages of lead acid and NiCd batteries	
	– Hazards	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– State the dangers involved in overcharging lead-acid and NiCd batteries – Indicate the behaviour of NiCd batteries in the case of too high a temperature (thermal runaway). – Indicate why charging of lead-acid batteries with too high a voltage is dangerous – State that NiCd batteries are monitored to avoid damages resultant from excessive temperature increase	
021 02 01 03	**Magnetism** – Permanent magnetism – State the properties of a magnet. – Name the two poles of a permanent magnet – List the ferromagnetic materials that can be used for permanent magnets – State the direction of the magnetic flux outside the magnetic poles and inside the magnet – Electromagnetism – State that an electrical current produces a magnetic field around a conductor and define the direction of that field – Indicate how the strength of the magnetic field changes if supported by a ferromagnetic core – Explain the purpose of a relay – Name the components of a relay – Explain the purpose of a circuit breaker – Name the components of a circuit breaker – Explain how the coil circuit is insulated from the contact circuit – Explain the difference between a normally-open, a normally-closed and a changeover contact in a relay.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Electromagnetic power – State how the inductance of a coil depends on the number of windings, the cross-sectional area of the coil the coil length and the magnetic conductivity. – Electromagnetic induction – Explain the principle of electromagnetic induction. – State how the induced voltage in a coil depends on the number of windings, the magnetic flux and the rate of change of the magnetic flux	
021 02 01 04	**Generators** – Alternator – Principle, function and applications – Describe the condition for a voltage to be induced in a conductor. – Name the type of voltage which is induced in a rotating conductor loop in a homogeneous magnetic field – Name the components of a simple generator. – Define resonance. – State in qualitative terms how voltage depends on number of turns, field strength, rpm and load – Define the term ”internal-pole machine”. – Name the components of an alternator. – Compare the alternator and the simple generator with regard to: voltage response at low rpm power/weight ratio brush sparking	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	current supply for the consumer AC-DC conversion – Describe the different generator switching possibilities in multiengine aircraft. – With regard to load distribution, compare and contrast the split system with the parallel system. – List the requirements to connect DC generators in parallel – Explain how control of load sharing is achieved when two DC generators are operating in parallel – Monitoring devices – Name different monitoring devices – Regulation, control and protection – Explain the principle of voltage control. – List the types of voltage regulators and explain their method of operation. – Explain why reverse current flow from the battery to the generator must be prevented. – Name the different types of reverse-current protection devices and explain how they work. – Describe the different alternator designs – Starter generator – Describe how the starter generator is constructed and indicate its purpose.	
021 02 01 05	**Distribution** – Current distribution (buses) – Explain the purpose of the bus – Name the purpose of the battery bus and of the hot bus	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Name the components of the electrical power supply system used in flight – State the number of ammeters in a multi generator system – Use a block diagram to describe the supply system used in flight – Monitoring of electrical systems – State the methods of monitoring of electrical systems – Name the components of a moving-coil instrument – Explain the function of a moving-coil instrument – Explain the function of a Wheatstone Bridge – Ammeter, voltmeter – State the difference between a voltmeter and an ammeter with regard to resistance – State the purpose of an ammeter and show how it is connected to the electrical load – State the purpose of a voltmeter and show how it is connected to the electrical load – Describe the possibilities for extending the measuring range of voltmeters and ammeters – Interpret the different ammeter indications of the ammeter which monitors the charge current of the battery. – Annunciators – Identify different types of annunciators. – Electrical consumers – List types of electrical consumers (loads) for an aircraft, and their different purposes: – lighting – heating	Given appropriate diagram

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– magnetic devices – avionics systems – instruments – Describe the components of a DC motor – Describe the circuitry for the field winding in the case of series, shunt, and compound wound motors. – Describe the RPM and torque behaviour of a series-wound motor and a shunt-wound motor as the load increases/decreases. – Explain how the direction of rotation of a DC motor can be changed. – Name typical applications for series and shunt field motor. – DC power distribution: – Construction, operation and system monitoring – Using simplified schematics, explain the construction of single- and multi-engined DC flight equipment – Using simplified schematics, show the effects of different switching operations. – Using simplified schematics, show the effects of the following cases: generator failure generator overloading overvoltage battery over/undercharge. – List the sources of external power supply. – List the significant points to be observed when operating with an external power supply.	

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	– State the effects on the progress of the flight if the generator or generator and battery fails. – State how fire, due to electrical causes, can be checked.	
021 02 01 06	**Inverter**	
	– State the purpose of static inverters – List the parts used in the construction of a static inverter. – Describe the function of a static inverter. – State the commonly used output voltages of inverters – Name typical applications for an inverter.	
021 02 01 07	**The aircraft structure as an electrical conductor**	
	– Use a block diagram to describe the flight supply system – Explain the purpose of electrical bonding – State which pole of the battery and which pole of the alternator are typically grounded to the fuselage in aircraft power supply. – State the advantages and drawbacks of electrical bonding – Explain why the aircraft must first be grounded in case of refueling. – Explain the purpose of ”static dischargers”	
021 02 02 00	**<u>Alternating current (ac)</u>**	
021 02 02 01	**General**	
	- Single and multi-phase AC - Draw a single-phase AC voltage in the form of a line and vector diagram. - Draw a three-phase AC voltage in the form of a line and vector diagram.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Describe the behaviour of an ohmic resistor in an AC circuit - Describe the behaviour of a capacitor in an AC circuit. - Describe the behaviour of a coil in an AC circuit. - State that in aircraft with AC power distribution a three phase system is used. - Frequency - Define frequency in qualitative terms and state the relevant unit of measurement. - Explain the use of a particular electrical frequency in aircraft. - Phase shift - Define phase shift in qualitative terms. - State the phase shift of an ideal inductance in an AC circuit. - State the phase shift of an ideal capacitor in an AC circuit. - State the possible range of phase shift for an electrical circuit consisting of inductance, capacitor and ohmic resistor supplied with AC voltage. - AC components - Name components which work only with AC	
021 02 02 02	**Generators** - Three phase generator/brushless generator (construction and operation) - Describe the components of a three-phase generator. - Explain how a three-phase generator works. - List possible types of connection for the 3 windings. - Describe how a three phase AC generator is usually connected.	

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	- Define phase and line voltage and state the voltage values used in aircraft. - State the relation between phase voltage and line voltage. - Name the principle involved in voltage control. - State in qualitative terms the relation between frequency, number of pole pairs, and RPM of a three-phase generator. - Generator drive - Constant speed drive (CSD) - Explain the purpose of a constant speed drive (CSD) - Name the different types of constant-speed drives. - List the component parts of a CSD. - Describe how, in a CSD, oil pressure and oil temperature are monitored - Explain what happens in the event of mechanical disconnect. - Explain the significance of the monitoring instruments. - Integrated drive - List the components of the integrated drive generator (IDG). - Describe the function of an IDG. - Explain the consequences of a mechanical disconnect during flight. - State that in the case of failure an indication is given to the pilot. - Variable speed constant frequency (VSCF) drive - Explain the purpose of a VSCF. - Describe how constant output voltage and frequency is achieved. - Explain the function of disconnect.	

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	- Explain the purpose of a VSCF - State that the voltage and frequency output of a VSCF is identical to the output of a hydraulic constant speed driven AC generator as well as to an IDG.	
021 02 02 03	**Ac power distribution**	
	- Construction, operation and monitoring - List the different types of electrical power supply in AC circuits. - Describe the power distribution in the case of a split system. - Explain the consequences of one generator failing. - State that the auxiliary power unit (APU) is fitted with a 3 phase AC generator for use on the ground and in flight. - Explain the construction of three-phase flight equipment. - List the different monitoring instruments for parallel and split system operation. - Protection circuits, paralleling of ac-generators - Explain how the bus bars are connected in the case of parallel connection. - Explain the conditions to be met for paralleling AC generators - Name the synchronization conditions for parallel connection of three-phase generators. - Describe how different reactive loads become compensated in the case of paralleled AC generators. - Describe how different real loads become compensated in the case of paralleled AC generators. - List different protective circuits for parallel operation.	Given electrical schematics
021 02 02 04	**Transformers**	
	- Function - Describe the task of a transformer.	

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	- State that AC transformers exist for single-phase AC and for three-phase AC. - Name the component parts of a transformer. - State in qualitative terms the dependence of I and U on the transformation rate.	
021 02 02 05	**Synchronous and asynchronous motors**	
	- Operation - Name the components of a synchronous motor. - Describe how a synchronous motor works. - State the relationship between RPM, frequency and number of pole pairs for a synchronous motor. - List the characteristics of a synchronous motor. - Name the components of a 3-phase asynchronous motor - Describe how a 3-phase asynchronous motor works. - Describe the relationship between the rotating velocity of the rotary field in the stator and the rotor RPM of the asynchronous motor. - Name the components of a 2-phase asynchronous motor. - List the characteristics of an asynchronous motor. - Explain how the direction of a 3 phase AC motor can be changed - Application - Name typical applications for an asynchronous motor.	
021 02 02 06	**Transformer rectifier units (tru)**	
	- Specify the purpose of a Transformer Rectifier Unit (TRU). - Explain the construction and output voltage of a TRU. - State that TRU's are used in commercial aircraft for supplying the DC network	

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021 02 03 00	**Semiconductor** - Principles of semiconductors - Compare and contrast conductors, semiconductors and insulators with regard to specific resistance. - Name basic materials for semiconductors. - State how the conductivity of semiconductors can be altered. - Describe the different types of behaviour of n-layer and p-layer materials. - Semiconductor resistors (properties and application) - Explain the functional principle involved in a transistor. - Identify the contacts of a transistor. - List different types of transistors. - List the applications of a transistor. - Rectifier (function and application) - State that a rectifier is used to convert AC voltage into DC voltage - Diode (function and application) - Indicate the principal function of a diode - Describe the functional principles of different types of diodes. - List typical applications for the different types of diodes.	
021 02 04 00	**Basic knowledge of computers** - Differentiate between an analog and a digital computer. - Explain the functional principles of an analog computer.	

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	- Name the components of a digital computer and describe their purposes.
	- Explain what is meant by the terms ”hardware” and ”software”.
	- Describe the task of the input interface.
	- Describe the task of the output interface.
	- Name the components of the CPU and explain their function.
	- State that all operations of a digital computer are based on logic 0 and logic 1 (binary system).
	- State that certain voltage values are assigned to the levels 0 and 1.
	- Identify the following numerical systems:
	  - decimal system
	  - binary system
	  - octal system
	  - hexadecimal system
	- Explain and convert the following numerical systems:
	  - decimal
	  - binary
	- State that digital memory can accept information only in binary form.
	- Explain the various types of memory.
	- State that a bit is the smallest information element in a digital system.
	- Explain the relationship between ”bits” and ”bytes”.
	- State that memory capacity is expressed in bytes.
	- Describe the purpose of an analogue/digital (A/D) converter.
	- Describe the purpose of a digital/analogue (D/A) converter.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- State that with digital data processing the information is converted into steps - Describe the function and components of an integrated circuit (IC). - List the applications of IC's.	
021 02 04 01	**Logic circuits**	
021 02 04 02	**Logical symbols**	
021 02 04 03	**Switching circuits and logical symbols**	
	- Explain the functional principles involved in different logical gates and assign the symbols. - State that the function of a logic gate can be described by a truth table. - Given simple circuits, interpret combinations of logic operations. - Explain the basic operating principle of a flip flop.	
021 02 05 00	**Basic radio propagation theory**	
021 02 05 01	**Basic principles**	

	- Electromagnetic waves
	  - List the bands of the frequency spectrum for electromagnetic waves.
	  - Define the following terms:
	  - superposition
	  - beat frequency
	  - fading
	  - mixture
	  - modulation
	- Wave length, amplitude, phase angle, frequency	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS

	- With reference to a sine wave, and using a line and vector diagram, define the following terms:
	  - amplitude
	  - angular frequency
	  - frequency
	  - wavelength
	 - Explain the relation between frequency, wavelength, and velocity of propagation.
	- Frequency bands, sideband, single sideband
	 - State the characteristics of the frequency bands.
	 - Identify typical applications for the frequency bands.
	 - Name the frequency band and corresponding wavelengths of different types of radio-electric equipment
	 - Define the term ”bandwidth”.
	 - State the relationship between bandwidth and minimum frequency spacing of transmitters.
	 - State the relationship between bandwidth and minimum frequency spacing of receivers.
	 - Explain how VHF communication is achieved.
	 - Explain how HF communication is achieved.
	- Pulse characteristics
	 - Define the following terms, as associated with a pulse string:
	  - pulse length
	  - pulse power
	  - continuous power
	- Carrier, modulation, demodulation	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Define the term ”Carrier Wave”. - Explain the purpose of a modulator and demodulator. - Types of modulation, (amplitude, frequency, pulse, multiplex) - Define the following types of modulation: - amplitude modulation (AM) - frequency modulation (FM) - pulse modulation, pulse coded modulation (PM, PCM) - State that FM modulation causes an increase in bandwidth if compared with AM. - Compare and contrast AM and FM with regard to interference and complexity of the equipment used. - List typical applications for AM, FM, PM. - State frequency range, channel spacing and type of modulation for a VHF-COM system. - Oscillation circuits - Explain the functional principle used in an oscillator. - Describe how an electrical resonant circuit is constructed. - Explain how a resonant circuit works. - Define the term ”resonant frequency”. - Define resonant frequency, bandwidth and selectivity. - Explain the piezo-electric effect in the case of a quartz crystal. - Compare and contrast an inductive/capacitive resonant circuit with a quartz crystal controlled resonant circuit with regard to frequency stability and frequency selection. - Name typical applications for inductive/capacitive resonant circuits and quartz crystal controlled resonant circuits.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Explain how capacitive reactance depends on the frequency. - Explain how the inductive reactance depends on the frequency. - Using diagrams, explain the functional principles involved in the magnetron and klystron. - Name typical applications for cathode ray tubes, magnetrons, klystrons. R/t airborne equipment Identify the task of a transmitter. Name the major components of a transmitter. Explain the purpose of an amplifier. Name types of amplifier. Explain the purpose of an oscillator. Explain the purpose of a channel selector. Explain the purpose of a frequency synthesizer. Explain the purpose of the power amplifier. Explain the purpose of a receiver. Name the main components of a receiver. Explain the purpose of filters. State that digital filters can be used in addition to as analog types. Explain the functional principles involved in: automatic volume control (AVC) automatic frequency control (AFC) squelch	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	beat frequency oscillator (BFO) Explain the purpose of the audio selector panel. Name the components of an audio selector panel Explain the purpose of: crew interphone maintenance interphone cabin interphone Explain the purpose of the VHF communication system. List the components of a VHF-COM system Describe how the microphone selector switch, receiver selector switch and filter switch are operated Explain the purpose of the HF-COM system. List the components of an HF-COM system. State the range of an HF-COM system. State the purpose of the SELCAL system. List the components of a SELCAL system Explain the functional and operating principles involved in a SELCAL system Describe the task of an emergency locator transmitter. State the VHF and UHF emergency frequencies Identify the switch-on options for the emergency locator transmitter: Describe the technical construction and principal function of a GPS, including the satellite and airborne equipment.	
021 02 05 02	**Antennas**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS

	- Characteristics
	  - Describe the current and voltage distribution for a dipole/monopole antenna
	  - Define the term ”antenna diagram” or ”polar diagram”.
	  - Draw the radiation diagram of a dipole.
	  - Define the term ”loaded antenna”
	  - List the different kinds of loaded antennas
	  - Explain the skin effect in relation to frequency
	  - Explain the bending of radio beams.
	  - Define the terms ”parasitic antenna” and ”parasitic radiator”.
	  - List causes of deflection of beams
	  - Indicate the characteristics of the radiation diagram of glide-slope (GS) transmitters which may involve risks
	  - Indicate the characteristics of the radiation pattern of the localizer (LOC) which may involve risks
	  - State the difference between VOR and DVOR
	  - Interpret the radiation pattern and polar diagram of the following ground equipment:
	  - marker
	  - glide-path transmitter, glideslope (GS)
	  - localizer (LOC)
	- Polarisation
	  - Define vertical and horizontal polarization.
	  - State that the antenna polarization is identical to the alignment of the antenna’s electrical field component	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Types of antennas	
	- Name the applications for different antenna arrays	
	- Illustrate the radiation patterns and applications for different antennas	
021 02 05 03	**Wave propagation**	
	- State that, where the atmosphere is subject to intensified ionization due to solar radiation, the propagation range of a radio signal is affected.	
	- List the factors that affect the degree of ionization.	
	- Show how ionization intensities vary with time and altitudes.	
	- List the layers of the ionosphere by height and diurnal variation.	
	- State the reasons for frequency-dependent physical phenomena of electromagnetic waves	
	- Explain the connection between frequency and range.	
	- Ground waves	
	- Define ‘ground wave’	Given appropriate diagram
	- Define ‘skip zone’ and ‘skip distance’	
	- Space waves	
	- Define ‘sky wave’	
	- Propagation with the frequency bands	
	- State how VHF and higher frequencies are propagated	
	- Calculate the reception range for VHF frequencies.	
	- State the reasons why ranges may vary from those expected.	
	- State the range of ground waves in the HF band.	
	- State that multiple reflections (from the ionized layers) can result in such large ranges that	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	worldwide communication is possible - Name the ionized layer which absorbs frequencies in the LF/MF band. - State that the range of the ground wave is greater over water than over land, and is also significantly affected by the transmitting power - State that the range in this band is increased at twilight and at night - State that radio waves in the VLF band propagate between the surface of the Earth and the ionosphere like a wave guide - State that the range permits global coverage if the transmitter is sufficiently powerful. - Frequency prognosis (prediction, MUF) - List the ranges of frequencies of the different navigational aids - Fading - Explain the reason for fading. - Factors affecting propagation (reflection, absorption, interference, twilight) - State that the direction of propagation is altered by refraction at shore-lines. - State that there may be reflections by terrain elevations, buildings, etc., leading to multi-path propagation effects - Shoreline, mountain, static - List bearing errors arising from atmospheric disturbances, and explain their causes and effects	
021 03 00 00	**POWERPLANT**	
021 03 01 00	**Piston Engine**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
021 03 01 01	**General**	
	- Name and identify the various types of engine design with regard to cylinder arrangement and working cycle.	
	- Describe the gas state changes, the valve positions and the ignition time during the four strokes of the theoretical piston engine cycle.	
	- Explain the main differences between the theoretical and practical four stroke piston engine cycles.	
	- Define the term „specific fuel consumption“.	
	- Define the term „engine efficiency“.	
	- Define the term „compression ratio“.	
	- Describe the main mechanical engine components and state their function.	
021 03 01 02	**Lubrication system**	
	- Name all tasks of a piston engine lubrication system.	
	- Describe the schematic construction of both a wet and dry sump lubrication system, list the main components with their function and state the disadvantages of each system.	
	- List the basic lubrication system monitoring instruments.	
	- Describe the term ‘viscosity’ including the effect of temperature.	
	- Describe the viscosity grade numbering system used in aviation.	
	- Compare straight oil and compounded oil.	
	- Describe all typical operational procedures regarding the lubrication system.	
021 03 01 03	**Air cooling**	
	- Specify the reasons for cooling a piston engine.	
	- Compare and contrast the advantages of liquid and air cooling systems.	
	- State that aero piston engines are air-cooled.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Identify the cylinder head temperature indication to monitor engine cooling. - Describe the task and the operation of cowl flaps. - Describe all operational procedures regarding the cooling system.	
021 03 01 04	**Ignition**	
	- State why aero piston engines are equipped with two electrically independent ignition systems. - Describe the construction and operation of a magneto ignition system with the aid of a schematic diagram. - Identify the auxiliary methods of spark augmentation, state their task and describe their operating principle. - Describe all checks to be carried out to ensure the serviceability of the ignition system – Define the spark advance	
021 03 01 05	**Engine fuel supply**	
	- State the basic tasks of a carburettor. - Describe the operating principle of the simple float chamber carburettor. - Explain the purpose of the venturi. - Describe the method of achieving correct mixture ratio over the engine speed range. - Describe the method of achieving reliable idle operation. - Describe the methods of obtaining mixture control including provision of a method of stopping the engine. - Explain the purpose and the operating principle of an accelerator pump. - Describe the purpose of a priming pump and explain its operation. - Describe the causes and effects of carburettor icing and the action to be taken if carburettor icing is suspected.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Name the meteorological conditions within which carburettor icing may occur. - Describe the indications that will occur upon selection of carburettor heat if ice is present or not. - Describe the functional check of the carburettor heat system. - Explain the effect of carburettor heat on mixture ratio. - Explain the reason for the use of alternate air on fuel injection systems and describe its operating principle. - Name the meteorological conditions within which intake icing may occur. - Describe the low pressure, continuous flow type fuel injection system used on light aircraft piston engines with the aid of a schematic diagram. - Explain the requirement for two different pumps in the fuel injection system and describe their operation. - Describe the task and explain the operating principle of the fuel and mixture control valves in the injection system. - Describe the task and explain the operating principle of the fuel manifold valve, the discharge nozzles and the fuel flow meter in the fuel injection system.	
021 03 01 06	**Engine performance** - Define the terms „pressure/density altitude“ and write down a simple equation to determine the pressure altitude. - Describe engine performance as a function of pressure and temperature. - Explain the effect of changes in aircraft altitude on the engine power. - Define the term „normally aspirated“ engine. - Define the term „critical altitude“. - Define “thermal efficiency”, “mechanical efficiency”, “volumetric efficiency” and state typical values for a normally aspirated engine.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
021 03 01 07	**Power Augmentation Devices** - Summarise the reason for the installation of Turbochargers and Superchargers in aircraft engines. - Describe the difference between turbochargers and superchargers. - Describe the principle of operation of a turbocharger. - Explain the difference between an altitude-boosted turbocharger and a ground-boosted turbocharger. - Explain the function of an intercooler. - Describe the purpose of the waste gate, its location and its operating principle. - List and describe methods of controlling the waste gate position. - Describe the positions of the waste gate throughout a normal flight. - Compare and contrast the curves of maximum power versus altitude of normally aspirated, turbo-charged and supercharged engines identifying significant points. - Describe the purpose and the operating principle of manifold pressure gauges. - Define the terms „full throttle height“ and „rated altitude“. - Define the term „turbo lag“.	
021 03 01 08	**Fuel** - Name the types / grades of fuel used today for aero piston engines. - Describe how different fuel grades are identified. - Define the term „octane ratio“. - Describe the combustion process inside a piston engine cylinder. - Define the term „flame rate“ and describe its variations depending on the fuel-air mixture. - Define the term „flash point”.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Define the term „detonation“ and describe the causes and effects of detonation. – Describe the term „pre-ignition” and describe the causes and effects of pre-ignition - Identify situations and power settings that promote detonation. - Describe how detonation is recognized and prevented. - List two anti-detonation fuel additives. - Describe the method of checking the fuel for water content. - State the typical value of fuel density for aviation gasoline. - Define and explain fuel volatility. - Define and explain “vapor locking”.	
021 03 01 09	**Mixture** - Define the terms „chemically correct ratio“, „best power ratio“, „lean (weak) mixture” and “rich mixture“. - Describe the advantages and disadvantages of weak and rich mixtures. - Describe the relation between specific fuel consumption and mixture ratio. - List the mixture ratios used for normal operation, depending on engine power. - Describe the use of the exhaust gas temperature as an aid to mixture setting. - Identify the mixture setting required for maximum power and for maximum fuel economy.	
021 03 01 10	**Propeller** - Describe the fixed pitch propeller, its operating modes and explain its disadvantage. - Explain why the propeller is twisted. - Describe a variable pitch propeller and explain its advantages by comparing it with the fixed pitch propeller. - Define the terms „Alpha range“ and „Beta range“ as applied to a variable pitch propeller.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Describe the operating principle of a single acting and a double acting variable pitch propeller. - Describe the operating principle of a constant speed propeller system for both single and multi engine aircraft with the aid of a schematic diagram. - Describe the operation of a constant speed propeller system during flight. Describe the operating principle of a constant speed propeller system when feathering and unfeathering a propeller, including the operation of cockpit controls. - Explain the purpose and the basic operating principle of an auto-feather system. - Describe the purpose of the beta range and how it is selected on the flight deck. - State the purpose and describe the operation of a low pitch stop (centrifugal latch). - Define the terms „synchronising“ and „synchrophasing“. - Describe the basic operating principle of synchronising and synchrophasing systems. - Define the term „propeller efficiency“. - Describe how the efficiency of fixed and variable pitch propellers varies with flightspeed - State the highest propeller efficiency usually attained. - Describe the checks to be carried out on the propeller after engine start. - State the purpose of reduction gearing. - Name the two typical types of reduction gearing. - State the purpose of a torque-meter and describe its operating principle.	
021 03 01 11	**Engine handling and manipulation** - Describe the necessity for checking the propeller for its physical condition before flight. - Describe the general procedures for setting the engine controls during a normal flight from engine start until shut-down. - State the possible use of time limits for take-off and climb power.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Define the term „rated power“ or „maximum continuous power“.	
021 03 01 12	**Operational criteria**	
	- State that for normal operations there is a maximum and minimum rpm.	
	- Define the term „critical rpm“ and state the consequence for engine operation	
021 03 02 00	**Turbine Engine**	
021 03 02 01	**Principles of Operation**	
	- Describe how the thrust force is developed by turbojet and turbofan engines.	
	- Describe how power is developed by turboprop engines.	
	- Describe the gas state changes in a gas turbine engine with the aid of a working cycle diagram.	
	- Explain why the available engine thrust is limited by the turbine inlet temperature of the gas.	
	- Name the main components of the different types of gas turbine engines.	
	- Define the terms ‘propulsive efficiency’ and ‘thermal efficiency’.	
	- Describe the influence of total compression ratio on thermal efficiency.	
	- Explain the variations of propulsive efficiency for turbojet, turbofan and turboprop engines.	
	- Define the term ‘specific fuel consumption’ for turbojets and turboprops.	
021 03 02 02	**Types of Construction**	
	- Describe the term ‘equivalent horsepower’.	
	- Describe the operating principle of turbojet, turbofan and turboprop engines.	
	- Define the term ‘bypass ratio’.	
	- List the advantages and disadvantages of turbojet, turbofan and turboprop engines.	
021 03 03 00	**Engine Construction**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS

021 03 03 01	**Air Inlet**
	- Name the most important tasks of the engine air inlet.
	- Describe the geometry of a pitot type subsonic air inlet.
	- Describe the gas parameter changes in a pitot air inlet at different flight speeds.
	- State the function of secondary air inlet doors.
	- Describe the purpose and the principle of operation of multi shock air inlets at supersonic flight speeds.
	- Name the different types of multi shock air inlets and identify them on different aircraft.
	- Describe the reasons for and the dangers of the following operational problems concerning the engine air inlet:
	  - airflow separations, especially in crosswinds on the ground
	  - inlet icing
	  - inlet damage
	  - foreign object ingestion
	  - heavy in-flight turbulence
	- Describe the action taken by the pilot to counteract the above problems
	- Describe conditions and circumstances during ground operations in which the danger may arise of foreign objects or persons being sucked into the air inlet.	

021 03 03 02	**Compressor** - List the purposes of the compressor. - Describe the types of centrifugal and axial compressors used in aircraft engines. - Name the main components of a compressor stage and describe their function. - Describe the gas parameter changes in a compressor stage.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS

	- Define the term pressure ratio and state its order of magnitude for a centrifugal compressor stage and for an axial compressor stage.
	- State the advantage of a double stage centrifugal compressor.
	- List the advantages and disadvantages of a centrifugal compressor compared with an axial type.
	- State that some engines use both axial and centrifugal compressors.
	- Explain the convergent air annulus through an axial compressor.
	- State the entrance and the outlet velocity of an axial compressor stage.
	- State that axial compressors have pressure ratios of up to 35 and outlet temperatures of up to 600°C.
	- Describe the reason for twisting the compressor blades with the aid of velocity triangles.
	- State the task of inlet guide vanes.
	- State the reason for the clicking noise if the compressor rotates on the ground, e.g. due to windmilling.
	- Describe the two (and three) shaft compressor design in modern engines and its principle, and list its advantages.
	- Define the terms ‘compressor stall’ and ‘surge’.
	- State that the following conditions are causes for stall and surge
	  - rapid increase in fuel flow during increase of RPM
	  - low engine RPM, e.g. idle
	  - strong crosswind on ground
	  - engine air inlet icing
	  - contaminated or damaged compressor blades
	  - damaged engine air inlet
	- Describe, in full, the following indications of stall and surge	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- thrust loss - abnormal engine noise - vibrations - RPM variations - increased EGT - sometimes burning gas out of inlet and exhaust - List the actions to be taken by the pilot in the case of surge. - Describe the constructional methods used to minimize the occurrence of stall and surge. - State measures taken by the pilot to prevent stall and surge. - Describe a compressor map (surge envelope) with RPM-lines, stall limit, steady state line and acceleration line.	
021 03 03 03	**Diffuser** - Describe the function of the diffuser.	
021 03 03 04	**Combustion Chamber** - Define the task of the combustion chamber. - List the requirements for combustion. - Describe the principle of operation of the combustion chamber. - State that the low flame front velocity is the reason for diffusing the airflow at the combustion chamber entrance. - Define the terms ‘primary airflow’ and ‘secondary airflow’. - Explain the mixture ratios fuel: primary airflow and fuel: total airflow. - Describe the change of the gas parameters (p,t,v) through the combustion chamber.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- State that the outlet temperature of the combustion chamber is between 1000°C and 1500°C. - Name the main components of a combustion chamber and their tasks. - Describe the 'multiple combustion chamber system', the 'tubo-annular, the annular and the reverse-flow annular combustion chamber' and state the differences between them. - Describe the principle of operation of the different fuel spray nozzles.	
021 03 03 05	**Turbine** - Explain the tasks of the turbine in single- and multi-shaft turbojets, turbofans and turboprops. - Name the main components of a turbine stage and their function. - Describe the gas parameter (p,t,v) changes in a turbine stage. - Describe the principles of operation of impulse, reaction and impulse-reaction axial turbines. - Explain the divergent gasflow annulus through the turbine. - Describe turbine blade convection, impingement and film cooling. - Explain why there is high mechanical and thermal stress in the turbine blades. - State that the exhaust gas temperature, measured after the high pressure turbine or after the low pressure turbine, is used to monitor the turbine stress. - Describe the effect of acceleration and deceleration on the EGT.	
021 03 03 06	**Jet Pipe** - Define the task of the jet pipe of the gas turbine engine. - Specify the danger created by the high velocity exhaust gas. - Explain the operating principle of the jet pipe. - Describe the gas parameter changes and exhaust mach-numbers in both a convergent and a convergent-divergent nozzle. - Define the term 'choked exhaust nozzle'.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Describe the two different exhaust nozzle systems of turbofan engines. - Explain how engine exhaust noise can be reduced.	
021 03 03 07	**Pressure, Temperature and Airflow in a Turbine engine**	
	- Describe the variation of the static pressure, the temperature and the axial velocity inside a gas turbine engine during cruise - Describe the differences between absolute, circumferential and axial velocity	
021 03 03 08	**Reverse Thrust**	
	- Describe the principle of thrust reversal. - List the occasions where reverse thrust may be required during operations. - Identify the advantage and disadvantage of using reverse thrust during normal operations. - Describe the operating problems which may occur when using reverse thrust, and explain what measures may be taken by the pilot to reduce these problems. - Describe the following reverser types: 'clamshell', 'external' and 'blocker door'. - Identify pneumatically-, hydraulically- and mechanically-driven thrust reversers. - Describe the control levers, their operation and the monitor lights provided for reverse thrust.	
021 03 03 09	**Performance and Thrust augmentation**	
	- Describe the operating principle of an afterburner. - Describe the operating principle of a water/methanol injection system, its purpose and the different points of injection. - Explain how a water/methanol injection system is activated.	
021 03 03 10	**Bleed air**	
	- Explain the different functions of bleed air.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Describe the effects of bleed air extraction on RPM, EGT, thrust, EGT and specific fuel consumption. - Identify situations in which the cabin air bleeds need to be closed.	
021 03 03 11	**Auxiliary Gearbox** - Define the tasks of the auxiliary gearbox. - Describe how the auxiliary gear is normally connected with the high pressure shaft of the engine.	
021 03 04 00	**Engine Systems**	

021 03 04 01	**Ignition**
	- Name the components of a gas turbine ignition system with the help of a schematic ignition system.
	- Describe the function of the components
	  - energy source
	  - igniter plugs
	  - start lever / eng. master switch
	  - start switch / eng. start selector / ign. selector
	- Name the different modes of operation of the ignition system and state when they are used
	  - ground start
	  - in-flight start
	  - continuous ignition
	  - automatic ignition	

021 03 04 02	**Starter** - Explain the principle of a turbine engine start.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS

	- Describe the following types of starters
	  - electric
	  - pneumatic
	- Describe a typical start sequence for a two-spool turbofan engine with a pneumatic starter.
	- Define the self sustaining speed and state its order of magnitude as approx. 30% N_2
	- State the idle speeds as approx. 60% N_2 and approx. 25% N_1.	

021 03 04 03	**Engine Start Malfunctions** - Describe an in-flight restart. - Describe the causes, indications and actions in the case of a wet start, hot start and hung start.	

021 03 04 04	**Fuel system**
	- Identify the components of a gas turbine fuel system and describe their function with the help of a schematic fuel system:
	  - ow pressure pump
	  - fuel heater
	  - fuel filter
	  - high pressure pump
	  - fuel control unit
	  - high pressure shut off valve
	  - pressurization and dump valve
	  - fuel injector nozzles
	- Name the two types of high pressure pump, both driven by the engine high pressure shaft.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Define the tasks and describe the operating principle of the fuel control unit. - Identify the input signals for the fuel control unit. - Name the different types of fuel control units. - Name the controls and indicators of the fuel system.	
021 03 04 05	**Lubrication**	

	- Name the type of oil used in gas turbine engines.
	- Describe the tasks of the lubrication system.
	- Name the components of a gas turbine engine lubrication system and describe their tasks with the aid of a system schematic:
	  - oil tank
	  - pressure pump
	  - oil cooler (oil-fuel heat exchanger)
	  - oil filter
	  - return pumps
	  - magnetic chip detectors
	  - centrifugal breather
	- Identify the indications used to monitor the lubrication system.	

021 03 04 06	**Fuel**	
	- List the types of fuel used for gas turbine engines and their flash and freezing points, their colour and their specific weight. - Identify the possible problems with the fuel at low temperatures. - State that the fuel must be checked for dissolved water.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
021 03 04 07	**Thrust**	
	- Describe the simple form of the thrust equation.	
	- State the idle values of RPM and thrust as approx. 25% N_1 and 5% of takeoff thrust.	
	- Describe the variation of thrust with altitude.	
	- Describe the thrust variation with TAS for turbojets, turbofans and turboprops with the help of the simple thrust equation.	
	- Define the term 'engine pressure ratio' (EPR).	
	- Describe the variation of thrust with outside air temperature.	
	- Interpret the term flat rated engine by describing the change of take-off thrust, turbine inlet temperature and engine RPM with OAT.	
	- Define the term 'engine thrust rating'.	
021 03 04 08	**Powerplant Operation and Monitoring**	
	- Name all engine ratings (takeoff, go-around, max. continuous, max. climb, max. cruise) and their use during operation.	
	- Distinguish between ground idle and flight idle by stating the reasons for the differences (short acceleration time, bleed air supply).	
	- Describe how thrust/power are controlled in turbojet, turbofan and turboprop engines.	
	- Describe the terms α-range and β-range of the turboprop power lever.	
	- Describe the differences in thrust lever operation between FADEC and non-FADEC equipped aircraft.	
	- Name the turbofan engine monitoring instruments and state their use.	
	- Name the turboprop engine monitoring instruments and state their use.	
021 03 05 00	**<u>Auxiliary Power Unit (APU)</u>**	
021 03 05 01	**General**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Explain the operating principle of the auxiliary power unit (APU) and list its tasks. - State that the APU is able to generate electric and pneumatic power. - State that the APU usually provides power on the ground when the engines are shut down, but also can be used to provide emergency power during flight, especially for ETOPS operations. - Define maximum operating and maximum starting altitude. - Describe how an APU is protected against overloading at high altitudes. - Name the typical APU controls and monitoring instruments. - Describe the APU's automatic shut-down protection in case of malfunctions.	
021 03 05 02	**Ram air turbine** - Explain the operating principle and the use of an extendable ram air turbine (RAT).	
021 04 00 00	**EMERGENCY EQUIPMENT**	
021 04 01 00	**Doors and Emergency Exits** - State the JAR-OPS requirements related to doors and emergency exits. - State the regulation about accessibility of emergency exits during aircraft operation. - Describe the operation of doors and emergency exits. - Name the maximum time allowed to open the doors and emergency exits. - Describe the inside and outside markings of doors and emergency exits. - State the purpose of floor exit markings. - State the regulation about passenger evacuation time through the emergency exits. - Name the requirement for the additional crew emergency exits. - Describe the use and operation of evacuation slides.	
021 04 02 00	**Smoke detection**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- State the JAR-OPS requirements related to smoke detection. - Name the different locations where smoke detectors have to be, or may be additionally, installed. - Explain the basic operating principle of the different smoke detection systems - Describe the smoke warning system operation, warnings, indications and function tests. - Explain why smoke warning systems are sometimes subject to false warnings.	
021 04 03 00	**Fire detection** - State the JAR-OPS requirements related to fire detection systems. - State the locations in an aircraft, where fire detection systems have to be installed. - State locations where fire detection systems could be additionally installed. - Explain the operating principle of the different fire detection sensors. - Describe the fire warning system operation, its warnings, its indications and function tests.	
021 04 04 00	**Fire Fighting Equipment** - State the JAR-OPS requirements for fire extinguishing equipment. - Explain the operating principle of a built-in fire extinguishing system. - Describe the operation, the extinguishing agent, the indications and the function test of a fire extinguishing system. - List the different fire extinguishing agents and their use at different types of fire.	
021 04 05 00	**Aircraft oxygen equipment** - State the JAR-OPS requirements for aeroplane oxygen equipment. - State the reasons why oxygen systems are required on transport aircraft. - State which type of aircraft must be equipped with oxygen systems and list the regulations when it has to be used.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Explain the basic operating principle of a cockpit oxygen system. - Describe the operation of cockpit oxygen masks. - Explain the basic operating principles of the two types of passenger oxygen systems. - Describe the actuation methods for passenger oxygen. - Identify the fire and explosion danger in relation to the use of oxygen and name the safety precautions.	
021 04 06 00	**Emergency equipment**	

	- State the JAR-OPS requirements for emergency equipment.
	- State that the emergency equipment has to be checked before flight.
	- Describe the required number, the types of agents with regard to the type of fire, and the operation of portable fire extinguishers.
	- Describe the operation of smoke masks and smoke protection hoods
	- Describe the purpose and the operation of a portable oxygen system.
	- State the legal requirements for carrying life jackets and life rafts on board.
	- Identify typical locations of life jackets and life rafts and describe their operation.
	- Describe the operation of emergency locator beacons / transmitters and their endurance.
	- Describe the use of the following additional emergency equipment of a transport aircraft:
	  - first aid kits whose contents comply with valid regulations
	  - doctor's kit
	  - flash lights, torches
	  - megaphones
	  - crash axe and fireproof gloves	