AIRLINE TRANSPORT PILOTS LICENSE

(020 00 00 00 - AIRCRAFT GENERAL KNOWLEDGE)

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
022 01 00 00	**<u>INSTRUMENTATION</u>**	
022 01 00 00	**<u>FLIGHT INSTRUMENTS</u>**	
022 01 01 00	**<u>Air Data Instruments</u>**	
022 01 01 01	**Pilot and Static Systems**	
	– State the purpose of the pitot and static system.	
	– Indicate the information provided by the pitot and static system.	
	– Name the components of the pitot and static pressure system.	
	– Pitot tube, construction and principles of operation	
	– Name and state the purpose of each element of the pitot tube.	
	– Explain the principles of operation of the pitot tube.	
	– Illustrate the distribution of the pitot pressure to instruments and systems.	
	– Indicate various locations of the pitot tube in relation to the direction of air flow.	
	– Name the existing pitot tube designs.	
	– Static source	
	– Explain the principle of operation of the static port.	
	– Illustrate the distribution of the static pressure to instruments and systems.	
	– Indicate various locations of the static port.	
	– Define the static pressure error	

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	– Describe the purpose of static balancing – Malfunction – State, in qualitative terms, the effects on the indications of altimeter, airspeed indicator and variometer (vertical speed indicator) in the event of a blockage or a break of: – Total pressure line – Static pressure line – Total and static pressure line – Heating – Explain the purpose of heating. – Interpret the effect of heating on sensed pressure. – Alternate static source – Explain why an alternate static source is required. – Compare alternate static pressure with normal static pressure – State that when the alternate pressure system is used, correction values can be taken from the Flight Manual. – State the operating principle of the existing versions of alternate pressure systems	
022 01 01 02	**Altimeter** – Construction and principles of operation	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– State the task of the altimeter. – Describe the fundamental principle of hydrostatic pressure. – Describe the measuring element of a pressure altimeter. – Explain how the altimeter is calibrated. – State in qualitative and quantitative terms the variation of atmospheric static pressure with altitude. – Name the components of the altimeter. – Explain how these components work together. – Identify the different types of altimeters. – Explain the connection between the altimeter indication and the reference pressure. – Compare the existing altimeter designs and identify their advantages and defects. – State how the non-linear distribution of atmospheric pressure is converted to linear indication. – Indicate methods of temperature compensation and matching to the barometric pressure gradient. – Display and setting – Define the different subscale settings. – Define QNH, QFE, flight level – Define height, indicated altitude, true altitude, pressure altitude and density altitude. – State that subscale-setting units are given in hPa or inches of mercury (inch Hg). Convert pressures from inches Hg to hPa.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Interpret the indications of the existing types of altimeters.	
	– Errors	
	– State the purpose of vibration (knocking or vibrator) in some altimeters.	
	– Describe the effect of blockage of the static intake on altimeter reading.	
	– Interpret the errors for the altimeter and describe their effects on practice.	
	– Describe how the use of an alternate static source affects the altimeter indications.	
	– State how instrument and static source errors can be corrected.	
	– Apply corrections from the Aircraft Operating Manual (AOM) to altimeter readings.	
	– Correction tables	
	– Find altimeter corrections from the Aircraft Operations Manual (AOM) to determine the error due to speed, weight and altitude.	
	– Tolerances	
	– State the maximum permissible tolerances for an altimeter.	
	– Describe the variation of tolerances with altitude.	
	– Describe how the magnitude of the tolerances varies with increase in altitude.	
022 01 01 03	**Airspeed Indicator**	
	– Construction and principles of operation	
	– State the task of the airspeed indicator.	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
	– Describe the measuring element of the airspeed indicator. – Name the components of the airspeed indicator. – State the relationship between static pressure, dynamic pressure and total pressure. – State the units of airspeed measurement in common use. – Identify the different airspeed indicator designs. – State how temperature effects are compensated. – Indicate methods of temperature compensation. – Speed indications – Define: – Indicated Air Speed (IAS) – Calibrated Air Speed (CAS) – Equivalent Air Speed (EAS) – True Air Speed (TAS) – Compare values of IAS, CAS, EAS, TAS and required corrections between the speeds. – Describe interrelationship between IAS, CAS, EAS, TAS, and Machnumber during climb and descent. – Define v_{S0}, v_{S1}, v_{FE}, v_{NO}, v_{NE}, v_{LO}, v_{LE}, v_{YSE} – Meaning of coloured arcs	

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	– Explain the colour codings of the airspeed indicator.	
	– Assign the following speeds to the colour codings: V_{SO}, V_{S1}, V_{FE}, V_{NO}, V_{NE}, v_{YSE}	
	– Maximum speed indicator, V_{MO}/M_{MO} pointer	
	– State the operating principle of the V_{MO} pointer in the Mach Limit Airspeed Indicator.	
	– Errors	
	– List the errors of the airspeed indicator and explain their causes.	
	– State when the compressibility error must be taken into account.	
	– State the maximum permissible tolerance for instrument error.	
	– State that the correction values for the static pressure source error can be taken from the Flight Manual.	
	– Describe the most probable effect on the airspeed indication if an alternate static source is used.	
	– Explain the effect of a blocked pitot tube on airspeed indications in straight and level flight, during climb and descent.	
	– Explain the effect of a blocked static intake on airspeed indications, in straight and level flight, during climb and descent.	
022 01 01 04	**Mach Meter**	
	– Mach number formula	
	– Write down the mach number formula.	

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	– Describe the interrelationship between CAS, EAS, TAS and mach number. – State the effect of temperature on the mach number. – Construction and principles of operation – State the task of the machmeter. – Explain the operating principle of the machmeter – Define the term ”Machnumber”. – State the purpose of the machmeter as compared to an airspeed indicator. – Name the different components of a machmeter. – Describe the basic construction and operation of the machmeter. – Name the pressure supply sources for the machmeter. – State the effect of temperature on the measurement of the machnumber. – Display – Interpret the indication of the machmeter. – State the relationship between indicated mach number and associated airspeed indication. – Calculate machnumber from TAS or CAS. – Calculate TAS from machnumber. – Construction types – Identify existing machmeter designs.	

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	– Errors – State the cause of instrument and position error. – Describe how instrument error varies with altitude and speed. – Describe the consequences of blockage of pressure supply. – State the tolerance of the machmeter.	
022 01 01 05	**Vertical Speed Indicator (VSI)** – Construction and principles of operation – Define vertical speed – State the purpose of the VSI – Explain the principles of operation of the VSI – State the method of operation of the capsule-type and dynamic-vane type VSI. – Name the components of the VSI. – State the purpose of the adjuster screw. – Compare capsule type and dynamic vane type VSIs in respect of the time lag in indication. – State the maximum permissible tolerance of the VSI. – Describe the behaviour of the VSI in the event of instrument failure.	

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	– Describe the effect of blockage of pressure source.	
	– Standard and Instantaneous VSI (IVSI)	
	– Name the existing variometer design.	
	– Describe the advantage of the IVSI over a standard VSI	
	– State the operating principle of an IVSI.	
	– State, in qualitative terms, how the indication on the IVSI alters on entering and exiting a turn in horizontal flight.	
	– State the effect of turbulence on the IVSI indication.	
	– Display	
	– State the units of measurement in common use.	
	– Describe how the VSI/IVSI information is presented to the pilot.	
022 01 01 06	**Air Data Computer (ADC)**	
	– Principles of operation	
	– State the purpose of the air data computer.	
	– Explain the operating principle of the air data computer.	
	– Name and compare the existing ADC designs.	
	– Name the different modules of an analog ADC.	
	– List the calculations carried out by an ADC.	

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	– Name the errors which the ADC corrects.	
	– Input and output data, signals	
	– Name the ADC inputs.	
	– Define and compare the following temperatures	
	– Total Air Temperature (TAT)	
	– Static Air Temperature (SAT)	
	– Outside Air Temperature (OAT)	
	– Calculate SAT according to TAT and machnumber	
	– Name and compare the measuring probes for total air temperature.	
	– State the purpose of a digital ADC pressure transducers.	
	– Uses of output data	
	– Identify the ADC outputs and the supplied units.	
	– Block diagram	
	– Illustrate a simple ADC, showing the processing of the input data to the final result as used by the relevant instruments.	
	– System monitoring	
	– Describe the effect of loss of input/output signal of the ADC to the pilot's instrument indication.	
022 01 02 00	**<u>Gyroscopic Instruments</u>**	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
022 01 02 01	**Gyro Fundamentals** – Theory of gyroscopic forces (stability, precession) – Define a gyro. – Define angular velocity, moment of inertia, torque and precession in relation to a gyro. – State and explain the fundamental properties of gyroscopes. – Explain how rigidity/precession can be increased/decreased. – Explain the movement of the gyro axis if under the influence of an external force. – Explain what is understood by a free and tied gyro. – Define the spin axis. Define the terms ‘drift’ (‘wander’) and ‘topple’. – Define a LASER gyro and compare it with a conventional gyro – Define a rate integrating gyro – Types, construction and principles of operation – Describe the use of, and the property primarily utilised by the vertical gyro, directional gyro, rate gyro, rate integrating gyro, single degree-of-freedom gyro and ring laser gyro. – State in which flight instruments gyros are used and the plane to which the gyro’s rotor axis is controlled. – Define the expression ‘gimbal ring’. – Define the degrees of freedom of rotation of a gyro.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Define the degrees of freedom of precession of a gyro.	
	– Apparent drift and apparent topple	
	– Interpret the following errors of a gyro:	
	– apparent topple	
	– apparent drift (wander)	
	– Explain the cause of apparent drift and apparent topple.	
	– Random drift	
	– Explain the causes of random drift.	
	– Mountings	
	– Explain how gyroscopes are mounted.	
	– Drive types, monitoring	
	– Identify the power supply of gyros.	
	– Identify and interpret the power supply indicators.	
	– For pneumatically driven gyros, explain the principles involved in the pump and governor.	
	– Name the components for pneumatic power supply.	
	– Name the existing types of electrical drives.	
	– Name the components for an electrical power supply.	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
	– Explain the advantages/disadvantages of suction driven and electrically driven gyroscopes. – Compare pneumatically and electrically driven gyro instruments with regard to use at high altitudes. – State the monitoring options for gyro instruments. – Interpret the effect of a defective power supply on the indicator functions of the gyro instruments. – Explain the reasons for using different types of gyro power supply on an aircraft.	
022 01 02 02	**Directional Gyro** – Construction and principles of operation – State the task of the Directional Gyro (DG) – Name the components of the directional gyro. – Describe the gimbal system. – State the directional stability of the gyro axis when rotating around the yaw axis of the aircraft. – Explain the effect of friction on the directional stability of the gyro. – State the purpose of an erection system. – Describe the different types of erection systems – State the speed of the erection system. – Define gimbal error – Explain the effect of gimbal error on bank and pitch.	

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	– Explain the necessity to reference the DG to the magnetic compass.	
	– Describe the adjustment procedure.	
	– Interpret the indicator of the DG.	
	– Calculate apparent drift of an uncompensated gyro (no random drift or transport drift) at given earth positions	
	– Compare the indications of a directional gyro and a magnetic compass during a turn and acceleration, and compare the accuracy of the indications over a lengthy period.	
	– Describe the behaviour of the instrument in the event of a gyro failure.	
022 01 02 03	**Slaved Gyro Compass**	
	– Construction and principles	
	– State the purpose of the slaved gyro compass.	
	– Explain the principles of operation of the slaved gyro compass	
	– Explain the principles of operation of the flux valve.	
	– Explain the functional principle involved in a flux detector with compensation device.	
	– Describe in general terms the signal flow.	
	– Using a block diagram, explain the operation of a remote compass system.	
	– Components	
	– List the main components and explain the function of a slaved gyro compass system (remote compass system).	Given appropriate diagram

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	– Name the magnetic sensing device of the remote compass system.	
	– Mounting and modes of operation	
	– Describe where and how the magnetic sensing device is mounted.	
	– State the different modes of operation	
	– Turn and acceleration errors	
	– Define:	
	– Turn error	
	– Acceleration error	
	– Deviation error	
	– Application, uses of output data	
	– List the instruments and other aircraft equipment, which utilise the output from a slaved gyro compass.	
	– Interpret information provided by the slaved gyro compass	
022 01 02 04	**Attitude indicator (vertical gyro)**	
	– Construction and principles of operation	
	– State the purpose of the attitude indicator.	
	– Describe the gyroscopic properties used in the instrument.	
	– State the plane of the gyro axis.	With the aid of a simple diagram

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	– Identify the components of the artificial horizon. – State the purpose of the adjuster knob for the aircraft symbol and the purpose of the knob for fast erection. – Explain the behaviour of the artificial horizon in the event of failure. – Describe different designs of artificial horizons. – Explain how mechanical and apparent topple are compensated. – State the erection speed of an artificial horizon. – Display types – Identify the purpose of the various instrument markings. – Turn and acceleration errors – Describe the effects, on the instrument indications, of aircraft acceleration and turns. – Explain how compensations for turn and acceleration errors are achieved in both pneumatically and electrically driven horizons. – Explain the purpose of the test function in the artificial horizon. – Application, uses of output data – Identify the location of the vertical gyro in the case of a remote horizon. – Describe how pitch and bank information is provided in case of a remote horizon – Identify the instruments/systems where the attitude information is utilised. – Describe the monitoring indications	

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022 01 02 05	**Turn and Bank Indicator (Rate Gyro)**	
	– Construction and principles of operation	
	– State the purpose of the turn and bank indicator (rate gyro).	
	– Identify the components of the turn and bank indicator.	With the aid of a simple diagram
	– Define rotational velocity around the yaw axis and the rate of turn.	
	– Explain the gyroscopic property used in the turn instrument.	
	– State the degrees of freedom of rotation and precession.	
	– Explain the movement of the pointer when performing a turn.	
	– State the plane of the gyro axis.	
	– State the number of gimbal rings.	
	– List the possible power supplies.	
	– Explain the movement of the ball (liquid level sensor) during a co-ordinated and a non co-ordinated turn.	
	– Explain the function of the warning flag.	
	– Display types	
	– Interpret the indication during a 2 min standard turn.	
	– Interpret the indication of the ball (liquid level sensor).	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
	– Application errors – Describe the instrument indication during a slip. – Describe the instrument indication during a skid. – Explain how to correct slip and skid in order to achieve co-ordinated flying. – State the behaviour of the instrument in the event of a turn and bank indicator failure. – Application, uses of output data – State the use of provided information. – List systems where rate information is used. – List different designs. – Explain how damping affects the indication. – Turn co-ordinator – Explain the purpose of turn co-ordinator. – Describe the construction of a turn co-ordinator.	
022 01 02 06	**Gyro Stabilised Platform (Gimballed Platform)** – Types in use – Explain the principle purpose and function of a gyro stabilised platform. – Identify the difference between a gimballed platform and a fixed installation (strap down system). – Describe how gimballed platforms can be stabilised.	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
	– Name different types of platform systems and describe the differences between them. – Accelerometer, measurement systems – Explain the use of accelerometers in a gyro stabilised platform. – Describe the construction of an accelerometer. – Explain the principle involved in a servo accelerometer. – Describe how the accelerometers are mounted. – Describe how accelerations are integrated to derive velocity and distance. – Explain the centrifugal, Coriol's and gravitational-corrections. – Construction and principles of operation – List and identify the components of a gimballed platform. – State the degrees of freedom of a gimballed platform. – Describe the method of operation of the different gyros in maintaining a level platform. – Describe the behaviour of a Schuler platform. – Identify the components of an Inertial Navigation System (INS). – List the capabilities of an INS system. – Describe the output signals of the INS. – Explain how magnetic north is calculated. – State that the Inertial Reference Unit (IRU) is a part of the INS.	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
	– State that the Control and Display Unit (CDU) is that part of the INS where all data is extracted and inserted	
	– Platform Alignment	
	– Name and define the modes of operation of the INS.	
	– Explain the conditions to be fulfilled when align mode is selected	
	– Explain the conditions to be fulfilled during system start-up	
	– Explain the align mode.	
	– Applications, uses of output data	
	– Describe the outputs of the INS in Navigation mode.	
	– Describe the outputs of the INS in Attitude mode.	
	– Name the inputs to the INS.	
	– Summarise the information available and state its uses.	
022 01 02 07	**Fixed Installations (Strap Down System)**	
	– Construction and principles of operation	
	– State the purpose of the strap down system.	
	– Describe the differences between a gimballed platform and a strap down system.	
	– Identify the types of gyro which are typically used for a strap down system.	
	– Explain the function of a tuned rotor gyro.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Explain the function of a Ring LASER Gyro (RLG).	
	– Explain the function of a Fibre Optic Gyro (FOG).	
	– Explain the operating principle of a strap down system and compare with gyro stabilised platform	
	– List the components of a strap down system.	
	– State that, through integration, it is possible to derive velocity and distance from acceleration.	
	– Types in use	
	– List the strap down systems which are typically used.	
	– Input signals	
	– List the input signals.	
	– Explain the principle of position updating by reference to ground stations or GPS.	
	– Application, uses of output data	
	– Name the components of an INS system.	
	– Identify the indicator which presents the attitude information.	
022 01 03 00	**<u>Magnetic Compass</u>**	
	– Construction and principles of operation	
	– State the role of the magnetic compass.	
	– State that the magnetic compass is often named as a stand-by compass.	
	– Describe the construction of the magnetic compass.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Explain the working principle.	
	– Describe the magnetic field of the earth and explain the effects of its inclination.	
	– Errors (deviation, effect of inclination)	
	– Describe and interpret the acceleration/deceleration and turning errors.	
	– Identify the geographical areas where the magnetic compass is unreliable.	
	– State possible disturbances of the Earth's magnetic field due to external magnetic field.	
	– State the causes of the aircraft's magnetic field and explain how it affects the accuracy of the compass indications.	
	– Explain the different types of deviation and their origins	
	– Explain how this deviation error changes with aircraft heading	
	– Explain how the deviation compensation device works.	
	– Explain why every magnetic compass requires a deviation table or curve mounted in the cockpit for pilot information.	
	– State the maximum permissible values for deviation and total tolerance.	
	– Cite examples of when knowledge of compass deviation is required.	
022 01 04 00	**<u>Radio Altimeter</u>**	
	– Components	
	– State the purpose of a radio altimeter.	
	– List the components of the radio altimeter.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– State the purpose of the decision height warning light	
	– Frequency band	
	– Identify the frequency band in which the radio altimeter operates.	
	– Principle of operation	
	– Explain the principles of operation.	
	– State operator control options for a radio altimeter.	
	– Display	
	– Illustrate and interpret different types of indication.	
	– State the maximum range for indication.	
	– List instruments or units which receive altitude information from the radio altimeter.	
	– Errors	
	– Describe the errors of the radio altimeter.	
022 01 05 00	**Electronic Flight Instrument System (EFIS)**	
	– Information display tubes	
	– Identify the components of a typical EFIS system.	
	– Describe the function of each of the EFIS system components.	
	– Indicate the range of input data sources available to a typical EFIS system.	
	– Primary Flight Display (PFD)	

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	– State that the PFD system displays mainly flight parameters.	
	– Identify the information available on the PFD.	
	– Describe the colour coding on the PFD.	
	– State which warning may be associated with the PFD.	
	– State that information is displayed via the Display Management Computer.	
	– Navigation Display (ND)	
	– State that the ND displays mainly navigation data.	
	– Name the typical display modes for ND.	
	– Identify the information available in the different modes.	
	– Describe the colour coding on the ND.	
	– State that information is displayed via the Display Management Computer.	
	– Data input	
	– List the EFIS inputs.	
	– Control panel, display unit	
	– State the function and describe the operation of the EFIS control panel.	Given appropriate drawing
	– Identify the types of display units.	
	– State that, in case of a display unit failure, switching to another display unit is possible.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– List the switching options in case of display-failure.	
	– Example of a typical aircraft installation	Given appropriate diagram
	– Explain the EFIS function and information interchange.	
022 01 06 00	**Flight Management System (FMS)**	
	– General principles	
	– State the role of the FMS.	
	– List the FMS components.	
	– State the number of FMS installed in aircraft.	
	– Name the systems which are connected to the FMS outputs.	
	– State the purpose of economy mode.	
	– Interpret fuel cost, time related cost, and fixed cost in relation to speed.	
	– Interpret fuel savings for climb, cruise, and descent in relation to trip distance.	
	– State the different operating modes of an FMS.	
	– Explain the differences between dual mode and independent mode.	
	– Identify different flight phases in relation to crew operated FMS handling.	
	– Interpret the components of a Multipurpose Control and Display Unit (MCDU).	
	– Identify the parameters that relate to the vertical flight profile.	
	– Explain the calculations in different flight phases.	

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	– State that the control of the different FMS modes is described in the Aircraft Operating Manual (AOM).	
	– Describe how the FMS functions are monitored.	
	– Inputs and outputs of data	
	– List FMS inputs.	
	– List FMS outputs	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
022 02 00 00	**AUTOMATIC FLIGHT CONTROL SYSTEMS**	
022 02 01 00	**Flight Director**	
	– Function and application	
	– Explain the purpose of the flight director commands for pitch and roll.	
	– Identify the inputs to the flight director computer.	
	– Block diagram, components	
	– Name the components of a flight director	
	– Identify the channels of the flight director computer	
	– Mode of operation	
	– Interpret the different operating modes and state the input information required	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS

	– Operation set up for various flight phases
	  – Describe the sequential logic switching for different vertical and lateral modes.
	  – Describe the selection and operation, by the pilot, of the following modes:
	    – take off
	    – climb
	    – cruise
	    – descent
	    – approach
	    – land
	    – go around
	– Command modes (bars)
	  – Explain the operating principle of the flight director computer
	  – Name the indicators in which the flight director command bars are displayed.
	  – Describe the different types of flight director command indications.
	  – Interpret the indications of command bars
	– Flight Mode Annunciator
	  – Explain the purpose of the flight mode annunciator.
	  – Describe the different designs of flight mode annunciators.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– System monitoring	
	– Identify the different inputs/outputs which are controlled by the flight director monitor.	
	– Identify and interpret the different monitoring options	
	– Limitations, operational restrictions	
	– Explain that the commands of the flight director are given in such a way that structural limits of the aircraft for pitch and bank attitude will not be exceeded	
	– Describe the task of the gain program in the approach mode.	
	– State the task of lateral and vertical beam sensors.	
	– Describe the disturbances which can be compensated for with the flight director.	
	– State how the commands of the flight director are affected by the rate of change of deviation.	
022 02 02 00	**Autopilot**	
	– Function and application	
	– Explain the different trim steering signals for elevator, aileron, rudder and elevator trim.	
	– Explain the function of the pitch channel automatic trim	
	– Explain the principle of operation of the Control Wheel Steering (CWS)	
	– State the function and describe the role of the autopilot.	
	– Types (different axes)	
	– Identify the different control channels of the autopilot.	

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	– State the JAR-OPS requirements concerning the use of the autopilot.
	– Block diagram, components
	    – Name the component units of an autopilot.
	    – Define the "control law" of an autopilot
	    – Identify different signal inputs into the autopilot system.
	    – List the different types of autopilot actuators.
	    – Describe the difference between open loop and closed loop control
	    – List the components of a closed loop control system and name the inputs/outputs
	    – Identify the different types of controller and state their control behaviour
	    – List typical applications for closed-loop controllers in aircraft
	
	– Lateral (roll) modes
	    – Describe the lateral modes of the autopilot.
	    – Identify the flight data which are used to set the bank in each of these modes
	– Longitudinal (pitch) modes
	    – Describe the pitch modes of the autopilot.
	    – List the flight data which are used to set the pitch in each of these modes.
	– Common modes	

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	– Describe the common modes of the autopilot. – Describe and interpret the task of the auto trim system in the case of autopilot engaged. – Autoland, sequence of operation – Explain the typical autoland sequence – Define automatic and semi-automatic landing – Identify the flight data which are used in autoland mode – System concepts for autoland, go around, take off, fail passive, fail operational (redundant) – Define ‘fail passive’ – Define ‘fail operational’ – State that the approach/land mode is a common mode and name the inputs required. – State that the autopilot cannot be used for take-off. – State that the number of autopilots/channels depends on the required property: fail safe, fail passive or fail operational – List the minimum requirement for an autoland. – Describe the role of the elevator trim system in the event of an autopilot failure – Describe the task of the position/trim indicator of the autopilot. – Define a fail safe autopilot.	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
	– Describe the task of the gain, flare and decrab programs in the approach/land mode. – Control modes – State the settings which can be entered at the control panel. – Describe the different control modes – Signal interfacing to autopilot actuators – State that the autopilot computer compares actual values with reference values and passes control commands to the autopilot actuators. – Explain that the position and rate of movement of the flight control surface is fed back to the autopilot computer – Describe the automatic synchronisation of the autopilot in ”Off” or ”Disengaged” mode – Explain how to handle a non self-synchronising autopilot before switching on – Operation and programming for various flight phases – Describe the following flight phases in relation to the autopilot condition: – take off – climb – cruise – descent – approach – land	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
	– go around	
	– Describe the connection between FMS and autopilot relative to mode programming.	
	– System monitoring	
	– Describe the task of the flight mode annunciator, the autopilot disengage light and aural warning	
	– Identify and interpret the visual and aural alerts	
	– Limitations, operational restrictions	
	– Describe the task of the autopilot engage interlock.	
	– State the conditions of engagement of an autopilot	
	– Name the maximum pitch and bank angle in case of engaged autopilot.	
	– Explain the purpose of gain adaption referring to IAS.	
	– Define the aircraft and autopilot conditions that are necessary before the autopilot is switched on.	
022 02 03 00	**Flight Envelope Protection**	
	– Function	
	– Describe the purpose and principle of flight envelope protection.	
	– Identify and describe the input data.	
	– Describe the output data.	
	– Explain system monitoring.	
022 02 04 00	**Yaw Damper**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Function	
	– State the purpose of the yaw damper computer.	
	– Identify the inputs of the yaw damper computer.	
	– State that the yaw damper computer compares reference signals with actual signals and passes control commands to the yaw damper servo of the rudder.	
	– State that fuselage vibrations can be reduced with the aid of the yaw damper computer and the rudder	
	– Interpret the information given by the yaw damper indicator	
	– Block diagram, components	
	– Name the component units of a yaw damper.	
	– State and interpret the monitoring options	
	– Signal interfacing to rudder	
	– State that the yaw damper movement is added/subtracted to/from the rudder deflection controlled by the autopilot or rudder pedals	
	– Describe the task of a transfer valve	
	– Identify the different power sources for stabilizer movement for small, medium and large aircraft	
022 02 05 00	**Automatic Pitch Trim**	
	– Function	
	– State the purpose of the trim system.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Describe the functional principle involved in the trim system.	
	– Input data, signals	
	– Identify the input data.	
	– Describe the output signals.	
	– Name the component units of the trim system.	
	– Mode of operation	
	– Describe the conditions in which the automatic trim system is active	
	– State that the autopilot is inoperative if the auto trim system is not available	
	– Horizontal stabilizer, trim tab actuator	
	– State how automatic trimming is effected.	
	– System monitoring, safety of operation	
	– State that warning lights can indicate a failure of the trim system.	
	– State that there is always a stabilizer trim indicator.	
	– State that, in the case of excessive trim input, an aural alert can sound.	
022 02 06 00	**<u>Thrust Computation</u>**	
	– Function	
	– Explain the task of the thrust computation system.	
	– Describe how engine power is calculated	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
	– Name the different modes for which the thrust computation will be calculated. – Define Engine Pressure Ratio (EPR) – Interpret the flexible take-off mode. – Describe the operating principle of the thrust computation system. – Describe the functions of the Full Authority Digital Engine Control (FADEC) – Name the component units of the power computation system. – Define the different flight modes which can be selected. – Describe the various performance modes and explain their use.	
	– Components – Name the component units of a thrust rating limit computer.	
	– Input data, signals – Identify the inputs for a thrust rating limit computer.	
	– Output data, signals – Identify the ouputs of the power computation system.	
	– System monitoring – State that indication lamp, display message and/or aural warning indicate a failure.	
022 02 07 00	**Auto Thrust**	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
	– Function and applications – Explain the task of the auto thrust system	
	– Block diagram, components – Name the component units of an automatic thrust control system	With the aid of a suitable simple diagram
	– Mode of operation – Describe the different operation modes. – Identify the inputs of the automatic thrust control system.	
	– Automatic operation mode selection – Explain the purpose of PMS and FMS	
	– Signal interfacing to throttle lever mechanism – Explain how the automatic thrust control system compares actual values with reference values and passes control commands to the servo-motors of the thrust levers. – State that there is a feedback in order to control thrust lever speed	
	– Operation and programming for various flight phases – List the modes that are engaged in the different flight phases.	
	– System monitoring – State and interpret the different monitoring options	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Limitations, operational restrictions	
	– Describe the limitations relative to ambient conditions and engine rating selection	
	– Warning modes	
	– Identify and describe the different modes	
JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
022 03 00 00	**WARNING AND RECORDING EQUIPMENT**	
022 03 01 00	**Warnings general**	
	– State that the function of the flight warning system.	
	– List the components of the Flight Warning System (FWS).	
	– Classification of warnings	
	– State that depending on the classification different alerts can be given.	
	– State that the FWS can produce general alerts and dedicated alerts	
	– Display, indicator systems	
	– Name different types of indicator systems.	
	– Identify different types of alert lights and their meanings.	
	– Identify and describe other kinds of warning indications.	
022 03 02 00	**Altitude Alert System**	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
	– Function	
	– State the function of an altitude alert system.	
	– Describe how to operate the altitude alert system and how to interprete the information	
	– Block diagram, components	Using an appropriate block diagram
	– Explain the function of an altitude alert system using an appropriate block diagram.	
	– Operation and system monitoring	
	– State that the altitude alert system compares the selected altitude with the actual altitude.	
	– Explain how the system is monitored.	
022 03 03 00	**Ground Proximity Warning System**	
	– Function	
	– Describe the role of the ground proximity warning system (GPWS).	
	– State the range of operation of the GPWS.	
	– Identify the standard GPWS warning profiles.	
	– Explain the function of the enhanced ground proximity warning system (EGPWS) and describe its modes.	
	– State the JAR-OPS requirements relative to the GPWS	
	– Block diagram, components	Given appropriate diagram

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Identify the components of the GPWS and explain their function.	
	– Input data, signals	
	– Identify the inputs of a GPWS computer.	
	– Identify the outputs of a GPWS.	
	– Warning modes	
	– List and describe the different modes	
	– System integrity test	
	– Explain the functions of the test device provided with the GPWS installation.	
022 03 04 00	**Traffic Collision Avoidance System TCAS II**	
	– Principles	
	– Describe the task of the TCAS II system.	
	– List the necessary TCAS II components.	
	– Explain the principle of TCAS II interrogations.	
	– State that ”escape manoeuvres” can be calculated only for the vertical axis (climb or descent).	
	– State how many ”escape manoeuvres” TCAS II equipment can calculate simultaneously.	
	– Define the types of antennas in use.	
	– Identify the equipment with which an intruder must be fitted in order to be detected by TCAS II.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Identify the inputs and outputs of TCASII. – Define the different TCAS warnings in order to priority. – Explain how the crew has to react on receipt of a given advisory. – List and explain the appropriate TCAS II graphic symbols and interpret their position on the display. – Describe the test result when testing the system – Define a Resolution Advisory (RA) and a Traffic Advisory (TA).	

022 03 05 00	**<u>Overspeed Warning</u>**
	– Function
	  – Explain the function of the overspeed warning system.
	  – Name the different types of warning.
	– Input data, signals
	  – List the overspeed warning system inputs.
	– Display, indicators
	  – State where the maximum allowable speed is shown.
	– Function test
	  – Describe the typical warning sound which will be heard in case of activating the test function
	– Effects on operation in case of failure	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– State that in case of system-failure the pilot will receive no warning if v_{MO} or M_{MO} is exceeded.	
022 03 06 00	**Stall Warning System**	
	– Function	
	– Describe the function of the stall warning system.	
	– Explain how the stall warning is given to the pilot.	
	– Indicate the regulatory margin between stall and stall warning	
	– Constituent components of a simplified system	
	– List the components of a stall warning system.	
	– Block diagram, components of a system with angle of attack indicator	Given appropriate diagram
	– Using a simple block diagram of the stall warning system, explain the task of the components.	
	– Identify the inputs of a stall warning system	
022 03 07 00	**Flight Data Recorder**	
	– Function	
	– State that commercial aircraft have a flight recorder which records parameters throughout the entire duration of the flight	
	– Name the different designs of flight recorder.	
	– Explain the relation between the flight recorder and the Aircraft Integrated Data System.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– State the JAR-OPS requirements relative to flight recorder – Block diagram, components – Name the components of a flight data recorder (FDR). – List the parameters that are recorded by the FDR. – State that data from the flight maintenance recorder can be printed out for purposes of maintenance. – State that aircraft relevant data can be transmitted from the aircraft integrated data system, at certain intervals, to ground. – Define the information which is entered into a flight maintenance recorder. – Operation – Identify the power source of the FDR. – System monitoring – Explain how the system is monitored.	
022 03 08 00	**Cockpit Voice Recorder** – Function – Explain the purpose of the voice recorder. – State the recording time of the voice recorder. – State that the voice recorder is a shock-, temperature- and fire-proofed recording unit – Explain the principle function of a voice recorder. – State the JAR-OPS requirements relative to cockpit voice recorder	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS

	– Block diagram, components
	  – List the components of the voice recorder.
	  – Identify the information recorded by the voice recorder
	– Operation
	  – Describe how the voice recorder is energized.
	  – Define the conditions for starting and stopping the recording.
	  – State that it is possible to erase the recording and the conditions.	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
022 04 00 00	**<u>POWERPLANT AND SYSTEM MONITORING INSTRUMENTS</u>**	

022 04 01 00	**<u>Pressure Gauge</u>**
	– Name the units of measurement customarily used for pressure.
	– Sensors
	  – Name the different pressure measuring elements and explain their method of operation.
	  – List and describe the different types of sensor according to the pressure to be measured
	– Pressure indicators
	  – Explain the functional principles involved in different pressure measurements.
	– Meaning of coloured arcs	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Interpret the coloured markings on the indicator units for pressure measurement.	
022 04 02 00	**Temperature Gauge**	
	– Identify applications of temperature gauges in aircraft engine monitoring systems.	
	– Sensors	
	– Identify temperature measuring elements and state their field of application.	
	– List and describe the different types of sensor according to the temperature to measure	
	– Explain the operating principle of each type of temperature gauge	
	– Compare the advantages and drawbacks of each temperature gauge	
	– Identify thermocouple applications.	
	– Define Total Air Temperature (TAT) and Static Air Temperature (SAT)	
	– Calculate SAT according to TAT	
	– Ram rise, recovery factor	
	– Explain the meaning of ram rise and the recovery factor	
	– Temperature indicators	
	– Identify different types of temperature indications.	
	– Describe the relationship between the sensed signal and the indicator.	
	– Meaning of coloured arcs	
	– Explain the meanings of coloured arcs.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
022 04 03 00	**<u>RPM Indicator</u>**	
	– Interfacing of signal pick-up to RPM gauge	
	– Name the component units of an RPM indicator.	
	– Describe the different types of interfacing of signal pick-up to RPM gauge	
	– Identify types of RPM indicator which, in the case of airborne power supply failure, will continue to indicate.	
	– RPM indicators, piston and turbine engines	
	– List different designs of RPM pick-ups and describe their method of operation.	
	– Name types of measured value transmission.	
	– Describe different designs of indicator units and their methods of operation.	
	– Name different types of RPM indicators.	
	– Explain the operating principles of each of these types	
	– State the advantages and drawbacks of each of these types	
	– Name the task and method of operation of the synchroscope.	
	– State the maximum RPM which can be shown by a trailing pointer.	
	– Meaning of coloured arcs	
	– Identify and explain markings on the indicator.	
022 04 04 00	**<u>Consumption Gauge</u>**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Fuel flowmeter (function, indicators) – Explain the role of the fuel-flow indicator. – Interpret the indications of the fuel flow indicator. – Explain the principles of fuel flow measurement. – Compare volumetric fuel flow-meter with mass fuel flow meter – Explain in qualitative terms the connection between fuel pressure and fuel flow. – State the units of fuel flow measurement. – Compare the units: volume per unit time with mass per unit time. – Compare and contrast different designs for fuel flow measurement systems. – State that the total consumption is obtained by integrating the rate of fuel consumption over time. – High pressure line fuel flow-meter (function, indications, failure warnings) – State that on jet engines and turboprop engines impeller type fuel flow transmitters are used in the high-pressure fuel line.	
022 04 05 00	**Fuel Gauge** – Measurement of volume/mass units – Describe the task of the fuel quantity gauges. – State that a quantity of liquid can be measured by volume or by mass – Measuring sensors – Identify options for measuring the volume of liquids and describe their methods of operation and	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS

	calibration.
	– Identify options for measuring the mass of liquids and describe their methods of operation and calibration.
	– Compare the advantages and drawbacks of each of these options
	– Explain the functional principle involved in capacitive quantity measurement.
	– Expalin how measuring errors due to changes in aircraft attitude, are compensated.
	– Content, quantity indicators
	– Interpret the indication for
	  – oil supply
	  – fuel supply
	  – hydraulic fluid supply
	– Explain the purpose of a totalizer.
	– Describe how a quantity gauge system can be checked.
	– Reasons for incorrect indications
	– Describe the effects of temperature changes and accelerations on the indications given by simple types of fuel quantity measurements.
	– State that water precipitated in the tank may result in errors in capacitive quantity measurement	

022 04 06 00	**Torque Meter** – Explain the task of the torque indicator.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS

	– Name methods of measurement used for torquemeters.
	– Describe the connection between power, torque and RPM.
	– Indicators, units
	  – Name the components of a torque measuring system.
	  – State the units of measurement customarily used.
	  – Name the components of a torque measuring system.
	– Meaning of coloured arcs
	  – Interpret the meaning of coloured arcs and limit markers.	

022 04 07 00	**<u>Flight Hour Meter</u>**
	– Drive source
	  – Describe the purpose of the flight hour meter system as used for aircraft engines
	  – Explain the principle of operation of the flight hour meter system
	  – State that a flight hour meter can be coupled to an airborne sensor which becomes activated at a certain speed.
	– Indicators
	  – Explain the indication of a flight hour meter	

022 04 08 00	**<u>Vibration Monitoring</u>**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS

	– Indicators, units
	  – Explain the task of the vibration meter.
	  – Name the components of the vibration meter.
	  – Explain the functional principle involved in vibration measurement.
	  – State that vibrations of all engines are typically indicated at the same time.
	  – Identify the units of measurement customarily used in vibration measuring devices.
	– Interfacing to bypass turbofan engines
	  – Indicate the location of engine vibration sensors in the case of turbofan engines.
	– Warning system
	  – Identify possible warning outputs.	

022 04 09 00	**Remote (signal) Transmission System**
	– Mechanical
	  – State that flap and gear position can be given by mechanical transmission
	– Electrical
	  – Describe how analog sensors transmit positions of different systems.
	  – Describe how the positions of different systems are transmitted.
	  – Explain the function of a remote control system.
	  – Describe the construction, function and principles of operation of different remote control systems.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Compare the advantages/disadvantages of different remote control systems.	
022 04 10 00	**<u>Electronic Displays (ECAM, EICAS)</u>**	
	– State that the Engine Indication and Crew Alerting System (EICAS) has, in principle, the same task as the Electronic Centralized Aircraft Monitoring (ECAM) system	
	– State the purpose of the ECAM/EICAS .	
	– Explain how to operate the ECAM/EICAS system.	
	– Describe the inhibiting functions in relation to different flight phases.	
	– Identify the display units (DU) of ECAM/EICAS System.	
	– Identify the types of DU's.	
	– Interpret the important colours used by the DU's.	
	– Explain the function of the control panel and how it is operated.	
	– Explain how to select different pages on the DUs.	
	– State that, in the case of a DU failure, switching to another DU is possible.	