022

INSTRUMENTATION

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
022 00 00 00	**INSTRUMENTATION**	
022 01 00 00	**FLIGHT INSTRUMENTS**	
022 01 01 00	**Air Data Instruments**	
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 – Describe the purpose of static balancing – Malfunction – State, in qualitative terms, the effects on the indications of altimeter, airspeed indicator and	

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	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 – 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.	

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	– 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. – 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.	

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	– 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. – 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	

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	descent. – Define v_{S0}, v_{S1}, v_{FE}, v_{NO}, v_{NE}, v_{LO}, v_{LE}, v_{YSE} – Meaning of coloured arcs – 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. – Describe the interrelationship between CAS, EAS, TAS and mach number. – State the effect of temperature on the mach number.	

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	– 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. – 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)**	

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	– 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. – 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)**	

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	– 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. – 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	

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	– Describe the effect of loss of input/output signal of the ADC to the pilot's instrument indication.	
022 01 02 00	**Gyroscopic Instruments**	
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.	
	– Define the degrees of freedom of precession of a gyro.	
	– Apparent drift and apparent topple	

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	– 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. – 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	

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	– 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. – 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	

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	– 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). – 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	Given appropriate diagram
022 01 02 04	**Attitude indicator (vertical gyro)** – Construction and principles of operation	

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	– State the purpose of the attitude indicator. – Describe the gyroscopic properties used in the instrument. – State the plane of the gyro axis. – 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	With the aid of a simple diagram
022 01 02 05	**Turn and Bank Indicator (Rate Gyro)**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– 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. – 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). – 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	With the aid of a simple diagram

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– 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. – 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.	

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	– 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. – 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	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– 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. – 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	**Magnetic Compass** – 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	**Radio Altimeter** – Components – State the purpose of a radio altimeter. – List the components of the radio altimeter. – State the purpose of the decision height warning light – Frequency band – Identify the frequency band in which the radio altimeter operates.	

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	– 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) – 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.	

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	– 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.	
	– Identify the types of display units.	Given appropriate drawing
	– State that, in case of a display unit failure, switching to another display unit is possible.	
	– 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.	

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	– 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. – 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	
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	

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	- 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.
	- 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	

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	- 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	**<u>Autopilot</u>** - 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. - 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	

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	- 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 - 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	

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	- 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. - 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	

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	- 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** - 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	

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	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	**<u>Automatic Pitch Trim</u>** - Function - State the purpose of the trim system. - 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	

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	- 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
	  - 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.	

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	- 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**	
	- Function and applications - Explain the task of the auto thrust system - Block diagram, components - Name the component units of an automatic thrust control system - 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	With the aid of a suitable simple diagram

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	
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**	
	- 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 - Explain the function of an altitude alert system using an appropriate block diagram. - Operation and system monitoring	Using an appropriate block diagram

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- 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
	- 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.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- 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. - 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	**Overspeed Warning** - 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	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Effects on operation in case of failure	
	- 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.	
	- 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.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- 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 - 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	**POWERPLANT AND SYSTEM MONITORING INSTRUMENTS**	
022 04 01 00	**Pressure Gauge**	
	- 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	
	- 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	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS

	- 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.	

022 04 03 00	**RPM Indicator**	

	- 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.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
022 04 04 00	**Consumption Gauge**	
	- 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 calibration.	
	- Identify options for measuring the mass of liquids and describe their methods of operation and calibration.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS

	- 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. - 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.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	- Meaning of coloured arcs - Interpret the meaning of coloured arcs and limit markers.	
022 04 07 00	**Flight Hour Meter**	
	- 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	**Vibration Monitoring**	
	- 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.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS

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.
	  - Compare the advantages/disadvantages of different remote control systems.	

022 04 10 00	**Electronic Displays (ECAM, EICAS)** - 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.	