CHAPTER 19: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 022 – Aircraft General Knowledge - Instrumentation
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

~~**Introduction**~~

INTRODUCTION (Issue n°2, according to SET reference):

As agreed with the industry, no line with a new syllabus reference (number) can be expected before June 2010. This new version includes only a few minor changes, listed below.

~~As agreed with the industry, modifications or deletion of LO lines are accepted for the next three years, but introduction of a new LO line is not to be expected. Nonetheless to enable the industry to prepare the appropriate material in due time, new lines expected are presented with the mention : to be introduced at a later date.~~

No JAR OPS ~~reference are~~references are used; EASA CS references are mentioned as appropriate.

022 01 01 00 Pressure gauge : Introduction of solid state sensors postponed at a latter date. EPR not for Helicopters.

022 01 04 00 Fuel flowmeters : units used for fuel flow when measured by volume per hour added and precisions given regarding the differnet types of fuel flowmeters.

022 01 05 00 Tachometer. See modifications below.

022 01 06 00 Engine thrust measurement : Applicability made for CPLA for consistency purpose with 021. Discussion between N1 and EPR transferred to 021.

022 01 07 00 Torquemeter : Brake/Shaft Horse power removed as torque unit. Introduction of percentage as a possible display for engine torque and reliability removed from the characteristics to be discussed.

022 02 01 01 Air data sensors - Pressure sensors - Introduction of impact pressure and a different wording for ‘manoeuvre induced errors’ is used. Solid state sensors will be introduced at a latter date.

022 02 02 00 Air data sensors - Temperature sensors : see minor changes below.

022 02 03 00 Air data sensors - Angle of Attack measurement : see minor changes below.

022 02 04 00 Air data sensors – Altimeter : see minor changes below and ‘operating principles’ added for consistency purposes with ASI

022 02 05 00 Air data sensors – Vertical speed indicator: ‘Operating principles’ added for consistency purposes with ASI.

022 02 06 00 Air data sensors – Airspeed indicator: the list of components is removed as being encompassed by the description of the operating principles.

022 03 03 00 Direct Reading Magnetic Compass: ‘Attitude error’ has been added.

022 04 02 00 Rate of turn indicator – Turn coordinator – Balance (slip) indicator: paragraph re-written.

022 04 03 00 Gyroscope – Attitude indicator: See changes below (two lines are affected, one has been removed).

022 04 06 00 Solid State Systems: new paragraph to be introduced at a latter date.

022 05 01 00 INS/IRS

022 06 02 00 Two sentences rewritten in one.

022 06 02 00 The complete sequences (VOR/LOC and ALT) are now listed.

022 06 03 00 New wording used (‘Explain’ instead of ‘State’) and one line added.

022 06 04 00 Applicability modified.

022 08 01 00 ‘Give example of’ instead of ‘Describe’, typing errors corrected. The difference between a conventional and a fly-by-wire aeroplane is made

022 08 02 00 Reference to the ‘narrow band pass filter’ removed.

022 08 03 00 Flight Envelop Protection: text modified.

022 12 03 00 Stall Warning Systems and 022 12 04 00 Stall protection systems: corrections, text modified for a better consistency

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| **Syllabus reference** | **Syllabus details and Learning Objectives** | *Aeroplane* | | *Helicopter* | | | *IR* |
|---|---|---|---|---|---|---|---|
| | | ATPL | CPL | ATPL /IR | ATPL | CPL | |
| **022 00 00 00** | **AIRCRAFT GENERAL KNOWLEDGE – INSTRUMENTATION** | | | | | | |
| **022 01 00 00** | **SENSORS AND INSTRUMENTS** | | | | | | |
| **022 01 01 00** | **Pressure gauge** | | | | | | |
| LO | Define pressure, absolute pressure and differential pressure. | x | x | x | x | x | |
| LO | List the following units used for pressure:<br>- Pascal,<br>- bar,<br>- inches of mercury (in Hg),<br>- pounds per square inch (PSI), | x | x | x | x | x | |
| LO | State the relationship between the different units. | x | x | x | x | x | |
| LO | List and describe the following different types of sensors used according to the pressure to be measured:<br>- aneroid capsules,<br>- bellows,<br>- diaphragms,<br>- bourdon tube. | x | x | x | x | x | |
| LO | Solid state sensors (to be introduced at a latter date) | x | x | x | x | x | |
| LO | For each type of sensor identify applications such as:<br>- liquid pressure measurement (fuel, oil, hydraulic),<br>- air pressure measurement (bleed air systems, air conditioning systems),<br>- Manifold Absolute Pressure (MAP) gauge, | x | x | x | x | x | |

LO

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | - pressure probes for Engine Pressure Ratio (EPR). | x | x | | | | |
| LO | Give examples of display for each of the applications above. | x | x | x | x | x | |
| LO | Explain the need for remote indicating systems. | x | x | x | x | x | |
| **022 01 02 00** | **Temperature sensing** | | | | | | |
| LO | Explain temperature. | x | x | x | x | x | |
| LO | List the following units that can be used for temperature measurement:<br>- Kelvin<br>- Celsius,<br>- Fahrenheit. | x | x | x | x | x | |
| LO | State the relationship between these different units. | x | x | x | x | x | |
| LO | Describe and explain the operating principles of the following types of sensors:<br>- expansion type ( Bi-metallic strip)<br>- electrical type (resistance, thermo-couple) | x | x | x | x | x | |
| LO | State the relationship for a thermo-couple between the electromotive force and the temperature to be measured. | x | x | x | x | x | |
| LO | For each type, identify applications such as:<br>- gas temperature measurement (ambient air, bleed air systems, air conditioning systems, air inlet, exhaust gas, gas turbine outlets),<br>- liquid temperature measurement (fuel, oil, hydraulic). | x | x | x | x | x | |
| LO | Give examples of display for each of the applications above. | x | x | x | x | x | |
| **022 01 03 00** | **Fuel gauge** | | | | | | |
| LO | State that the quantity of fuel can be measured by volume or mass. | x | x | x | x | x | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List the following units used for fuel quantity when measured by mass:<br>- kilogramme<br>- pound | x | x | x | x | x | |
| LO | State the relationship between these different units. | x | x | x | x | x | |
| LO | Define capacitance and permittivity, and state their relationship with density. | x | x | x | x | x | |
| LO | List and explain the parameters than can affect the measurement of the volume and/or mass of the fuel in a wing fuel tank:<br>- temperature<br>- aircraft accelerations and attitudes<br>and explain how the fuel gauge system design compensates for these changes. | | | | | | |
| LO | Describe and explain the operating principles of the following types of fuel gauges:<br>- float system<br>- capacitance type fuel gauge system<br>- ultra-sound type of fuel gauge: to be introduced at a later date. | x | x | x | x | x | |
| **022 01 04 00** | **Fuel Flowmeters** | | | | | | |
| LO | Define fuel flow and where it is measured. | x | x | x | x | x | |
| LO | State that fuel flow may be measured by volume or mass per unit of time. | x | x | x | x | x | |
| LO | List the following units used for fuel flow when measured by mass per hour:<br>- Kilogrammes/hour<br>- Pounds/hour | x | x | x | x | x | |
| LO | List the following units used for fuel flow when measured by volume per hour:<br>- Liters/hour<br>- US Gallons/hour | x | x | x | x | x | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List and describe the following different types of fuel flowmeter:<br>- mechanical<br>- electrical (analog)<br>- electronic (digital)<br>and explain how the signal can be corrected to measure mass flow. | x | x | x | x | x | |
| LO | Explain how total fuel consumption is obtained | x | x | x | x | x | |
| **022 01 05 00** | **Tachometer** | | | | | | |
| LO | List the following types of tachometers:<br>- mechanical (rotating magnet)<br>- electrical (three phase tacho-generator)<br>- electronic (impulse measurement with speed probe and phonic wheel)<br>and for each type describe its operating principle. | x | x | x | x | x | |
| LO | For each type, identify applications such as engine speed measurement (crankshaft speed for piston engines, spool speed fo gas turbine engines), wheel speed measurement for anti-skid systems (anti-skid systems for aeroplane only) and give examples of display. | x | x | x | x | x | |
| LO | State that engine speed is most commonly displayed as a percentage. | x | x | x | x | x | |
| **022 01 06 00** | **Thrust measurement** | | | | | | |
| LO | List and describe the following two parameters used to represent thrust : N1, EPR. | x | x | | | | |
| LO | Explain the operating principle of the EPR gauge and the consequences for the pilot in case of a malfunction including blockage and leakage. | x | x | | | | |
| LO | Give examples of display for N1 and EPR. | x | x | | | | |
| **022 01 07 00** | **Engine Torquemeter** | | | | | | |
| LO | Define Torque. | x | x | x | x | x | |
| LO | Explain the relationship between Power, Torque and RPM. | x | x | x | x | x | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List the following units used for torque:<br>- Newton meters<br>- Inch or Foot pounds | x | x | x | x | x | |
| LO | State that engine torque can be displayed as a percentage. | x | x | x | x | x | |
| LO | List and describe the following different types of torquemeters:<br>- mechanical<br>- electronic<br>and explain their operating principles. | x | x | x | x | x | |
| LO | Compare the two systems with regard to design and weight. | x | x | x | x | x | |
| LO | Give examples of display. | x | x | x | x | x | |
| **022 01 08 00** | **Synchroscope** | | | | | | |
| LO | State the purpose of a synchroscope. | x | x | | | | |
| LO | Explain the operating principle of a synchroscope. | x | x | | | | |
| LO | Give examples of display. | x | x | | | | |
| **022 01 09 00** | **Engine Vibration monitoring** | | | | | | |
| LO | State the purpose of a vibration monitoring system for a jet engine. | x | x | | | | |
| LO | Describe the operating principle of a vibration monitoring system using the following two types of sensors:<br>- piezo electric crystal<br>- magnet. | x | x | | | | |
| LO | State that no specific unit is displayed for a vibration monitoring system. | x | x | | | | |
| LO | Give examples of display. | x | x | | | | |
| **022 01 10 00** | **Time measurement** | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Explain the use of time/date measurement and recording for engines and system maintenance. | x | x | x | x | x | |
| **022 02 00 00** | **MEASUREMENT OF AIR DATA PARAMETERS** | | | | | | |
| **022 02 01 00** | **Pressure measurement** | | | | | | |
| **022 02 01 01** | **Definitions** | | | | | | |
| LO | Define static, total and dynamic pressures and state the relationship between them. | x | x | x | x | x | x |
| LO | Define impact pressure as total pressure minus static pressure and discuss the conditions when dynamic pressure equals impact pressure. | x | x | x | x | x | x |
| **022 02 01 02** | **Pitot/static system: design, and errors.** | | | | | | |
| LO | Describe the design and the operating principle of a:<br>- static source<br>- pitot tube<br>- combined pitot/static probe | x | x | x | x | x | x |
| LO | For each of these indicate the various locations, describe the following associated errors:<br>- position errors<br>- instrument errors<br>- errors due to a non longitudinal axial flow (including manoeuvre-induced errors),<br>and the means of correction and/or compensation. | x | x | x | x | x | x |
| LO | Describe a typical pitot/static system and list the possible outputs. | x | x | x | x | x | x |
| LO | Explain the redundancy and the interconnections of typical pitot/static systems. | x | x | x | x | x | x |
| LO | Explain the purpose of heating and interpret the effect of heating on sensed pressure. | x | x | x | x | x | x |
| LO | List the affected instruments and explain the consequences for the pilot in case of a malfunction including blockage and leakage. | x | x | x | x | x | x |
| LO | Describe alternate static sources and their effects when used. | x | x | x | x | x | x |

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|---|---|---|---|---|---|---|---|
| LO | Solid state sensors (to be introduced at a latter date) | x | x | x | x | x | x |
| **022 02 02 00** | **Temperature measurement** | | | | | | |
| **022 02 02 01** | **Definitions** | | | | | | |
| LO | Define OAT, SAT, TAT and measured temperature. | x | x | x | x | x | x |
| LO | Define ram rise and recovery factor. | x | | | | | |
| LO | State the relationship between the different temperatures according to Mach number. | x | | | | | |
| **022 02 02 02** | **Design and operation** | | | | | | |
| LO | Describe the following types of air temperature probes and their features:<br>- expansion type: Bi-metallic strip, direct reading<br>- electrical type wire resistance, remote reading | x | x | x | x | x | x |
| LO | For each of these indicate the various locations, describe the following associated errors:<br>- position errors<br>- instrument errors<br>and the means of correction and/or compensation. | x | x | x | x | x | x |
| LO | Explain the purpose of heating and interpret the effect of heating on sensed temperature. | x | x | x | x | x | x |
| **022 02 03 00** | **Angle of Attack measurement** | | | | | | |
| LO | Describe the following two types of angle of attack sensors:<br>- null seeking (slotted) probe<br>- vane detector | x | x | | | | |
| LO | For each type, explain the operating principles. | x | x | | | | |
| LO | Explain how both types are protected against ice. | x | x | | | | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Give examples of systems that use the angle of attack as an input, such as :<br>- Air Data Computer,<br>- Stall Warning Systems,<br>- Flight Envelope Protection systems. | x | x | | | | |
| LO | Give examples of different types of Angle of Attack (AoA) displays. | x | x | | | | |
| **022 02 04 00** | **Altimeter** | | | | | | |
| LO | Define ISA. | x | x | x | x | x | x |
| LO | List the following two units used for altimeters:<br>- feet<br>- meters<br>and state the relationship between them. | x | x | x | x | x | x |
| LO | Define the following terms:<br>- height, altitude,<br>- indicated altitude, true altitude,<br>- pressure altitude, density altitude. | x | x | x | x | x | x |
| LO | Define the following barometric references: QNH, QFE, 1013,25. | x | x | x | x | x | x |
| LO | Explain the operating principles of an altimeter. | x | x | x | x | x | x |
| LO | Describe and compare the following three types of altimeters:<br>- simple altimeter (single capsule)<br>- sensitive altimeter (multi capsule)<br>- servo-assisted altimeter | x | x | x | x | x | x |
| LO | Give examples of associated displays: pointer, multi pointer, drum, vertical straight scale | x | x | x | x | x | x |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Describe the following errors:<br>- pitot/static system errors<br>- temperature error (air column not at ISA conditions)<br>- time lag (altimeter response to change of height)<br>and the means of correction. | x | x | x | x | x | x |
| LO | Give examples of altimeter corrections table from an Aircraft Operations Manual (AOM). | x | x | x | x | x | x |
| LO | Describe the effects of a blockage or a leakage on the static pressure line . | x | x | x | x | x | x |
| **022 02 05 00** | **Vertical Speed Indicator (VSI)** | | | | | | |
| LO | List the two units used for VSI:<br>- meters per second<br>- feet per minute<br>and state the relationship between them. | x | x | x | x | x | x |
| LO | Explain the operating principles of a VSI. | x | x | x | x | x | x |
| LO | Describe and compare the following two types of vertical speed indicators:<br>- barometric type<br>- inertial type (inertial information provided by an Inertial Reference Unit) | x | x | x | x | x | x |
| LO | Describe the following VSI errors:<br>- pitot/static system errors<br>- time lag<br>and the means of correction. | x | x | x | x | x | x |
| LO | Describe the effects on a VSI of a blockage or a leakage on the static pressure line. | x | x | x | x | x | x |
| LO | Give examples of VSI display. | x | x | x | x | x | x |
| **022 02 06 00** | **Airspeed Indicator (ASI)** | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List the following three units used for airspeed:<br>- Nautical miles/hour (knots)<br>- Statute miles/hour<br>- Kilometers/hour<br>and state the relationship between them. | x | x | x | x | x | x |
| LO | Define IAS, CAS, EAS, TAS and state and explain the relationship between these speeds. | x | x | x | x | x | x |
| LO | Describe the following ASI errors and state when they must be considered:<br>- pitot/static system errors<br>- compressibility error<br>- density error | x | x | x | x | x | x |
| LO | Explain the operating principles of an ASI (as appropriate to aeroplanes or helicopters). | x | x | x | x | x | x |
| LO | Give examples of ASI display: pointer, vertical straight scale. | x | x | x | x | x | x |
| LO | Interpret ASI corrections tables as used in an Aircraft Operations Manual (AOM) | x | x | x | x | x | x |
| LO | Define and explain the following colour codings that can be used on an ASI:<br>- White arc (flap operating speed range)<br>- Green arc (normal operating speed range)<br>- Yellow arc (caution speed range)<br>- Red line (VNE)<br>- Blue line (best rate of climb speed, one engine out for multi engine piston light aeroplanes) | x | x | | | | |
| LO | Describe the effects on an ASI of a blockage or a leak in the static and/or total pressure line(s). | x | x | x | x | x | x |
| **022 02 07 00** | **Machmeter** | | | | | | |
| LO | Define Mach number, and local speed of sound (LSS) and perform simple calculations that include these terms. | x | | | | | |

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|---|---|---|---|---|---|---|---|
| LO | Describe the operating principle of a Machmeter . | x | | | | | |
| LO | Explain why a Machmeter suffers only from pitot/static system errors. | x | | | | | |
| LO | Give examples of Machmeter display: pointer, drum, vertical straight scale, digital. | x | | | | | |
| LO | Describe the effects on a Machmeter of a blockage or a leakage in the static and/or total pressure line(s). | x | | | | | |
| LO | State the relationship between Mach number, CAS and TAS and interpret their variations according to FL and temperature changes. | x | | | | | |
| LO | State the existence of MMO. | x | | | | | |
| **022 02 08 00** | **Air Data Computer** | | | | | | |
| LO | Explain the operating principle of an ADC. | x | | x | x | | |
| LO | List the following possible input data:<br>- static pressure<br>- total pressure<br>- measured temperature<br>- angle of attack<br>- flaps and landing gear position<br>- stored aircraft data | x | | x | x | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List the following possible output data:<br>- IAS<br>- TAS<br>- OAT<br>- TAT<br>- Mach number<br>- Angle of attack<br>- Altitude<br>- Vertical speed<br>- VMO/MMO pointer | x | | x | x | | |
| LO | For each output, list the datum/data sensed and explain the principle of calculation. | x | | x | x | | |
| LO | Explain how position, instrument, compressibility and density errors can be compensated/corrected to achieve a TAS calculation. | x | | x | x | | |
| LO | Explain why accuracy is improved for each output datum when compared to raw data. | | | | | | |
| LO | Give examples of instruments and/or systems which may use ADC output data. | x | | x | x | | |
| LO | State that an ADC can be a stand alone system or integrated with the Inertial Reference Unit (ADIRU). | x | | x | x | | |
| LO | Explain the ADC architecture for air data measurement including sensors, processing units, and displays as opposed to stand alone air data measurement instruments. | x | | x | x | | |
| LO | Explain the advantage of an ADC for air data information management compared to raw data. | x | | x | x | | |
| **022 03 00 00** | **MAGNETISM – DIRECT READING COMPASS AND FLUX VALVE** | | | | | | |
| **022 03 01 00** | **Earth's magnetic field** | | | | | | |
| LO | Describe the magnetic field of the earth | x | x | x | x | x | x |
| LO | Explain the properties of a magnet. | x | x | x | x | x | x |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Define the following terms:<br>- magnetic variation,<br>- magnetic dip (inclination), | x | x | x | x | x | x |
| **022 03 02 00** | **Aircraft magnetic field** | | | | | | |
| LO | Define and explain the following terms:<br>- magnetic and non-magnetic material<br>- hard and soft iron<br>- permanent magnetism and electro-magnetism | x | x | x | x | x | x |
| LO | Explain the principles and the reasons for~~of the following procedures~~:<br>- compass swinging (determination of initial deviations)<br>- compass compensation (correction of deviations found)<br>- compass calibration (determination of residual deviations) | x | x | x | x | x | x |
| LO | List the causes of the aircraft's magnetic field and explain how it affects the accuracy of the compass indications. | x | x | x | x | x | x |
| LO | Describe the purpose and the use of a deviation correction card. | x | x | x | x | x | x |
| **022 03 03 00** | **Direct Reading Magnetic Compass** | | | | | | |
| LO | Define the role of a direct reading magnetic compass. | x | x | x | x | x | x |
| LO | Describe and explain the design of a vertical card type compass. | x | x | x | x | x | x |
| LO | Describe the deviation compensation. | x | x | x | x | x | x |
| LO | Describe and interpret the effects of the following errors:<br>- acceleration<br>- turning<br>- attitude<br>- deviation. | x | x | x | x | x | x |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Explain how to use and interpret the direct reading compass indications during a turn | x | x | x | x | x | x |
| **022 03 04 00** | **Flux valve** | | | | | | |
| LO | Explain the purpose of a flux valve | x | x | x | x | x | x |
| LO | Explain the operating principle | x | x | x | x | x | x |
| LO | Indicate various locations and precautions needed. | x | x | x | x | x | x |
| LO | Give the remote reading compass system as example of application. | x | x | x | x | x | x |
| LO | State that because of the electromagnetic deviation correction, the flux valve output itself does not have a deviation correction card. | x | x | x | x | x | x |
| LO | Describe and interpret the effects of the following errors:<br>- acceleration,<br>- turning,<br>- attitude,<br>- deviation. | x | x | x | x | x | x |
| **022 04 00 00** | **GYROSCOPIC INSTRUMENTS** | | | | | | |
| **022 04 01 00** | **Gyroscope: basic principles** | | | | | | |
| LO | Define a gyro | x | x | x | x | x | x |
| LO | Explain the fundamentals of the theory of gyroscopic forces | x | x | x | x | x | x |
| LO | Define the degrees of freedom of a gyro.<br>*Remark: As a convention, the degrees of freedom of a gyroscope do not include its own axis of rotation (the spin axis).* | x | x | x | x | x | x |
| LO | Explain the following terms:<br>- rigidity,<br>- precession,<br>- wander (drift/topple) | x | x | x | x | x | x |

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|---|---|---|---|---|---|---|---|
| LO | Distinguish between:<br>- real wander and apparent wander<br>- apparent wander due to the rotation of the Earth and transport wander | x | x | x | x | x | x |
| LO | Describe a free (space) gyro and a tied gyro. | x | x | x | x | x | x |
| LO | Describe and compare electrically and pneumatically driven gyroscopes. | x | x | x | x | x | x |
| LO | Explain the construction and operating principles of a:<br>- rate gyro<br>- rate integrating gyro | x | x | x | x | x | x |
| **022 04 02 00** | **Rate of turn indicator /- Turn Co-ordinator – Balance (Slip) Indicator** | | | | | | |
| LO | Rate of turn indicator (1) – Turn co-ordinator (2) | | | | | | |
| LO | Explain the purpose of a rate of turn and balance (slip) indicator. | x | x | x | x | x | x |
| LO | Define a rate-one turn. | x | x | x | x | x | x |
| LO | Describe the construction and principles of operation of a rate of turn indicator. | x | x | x | x | x | x |
| LO | State the degrees of freedom of a rate of turn indicator. | x | x | x | x | x | x |
| LO | Explain the relation between bank angle, rate of turn and TAS. | x | x | x | x | x | x |
| LO | Explain why the indication of a rate of turn indicator is only correct for one TAS and when turn is co-ordinated. | x | x | x | x | x | x |
| LO | Describe the construction and principles of operation of a balance (slip) indicator. | | | | | | |
| LO | Explain the purpose of a balance (slip) indicator. | x | x | x | x | x | x |
| LO | Describe the indications of a rate of turn and balance (slip) indicator during a balanced, slip or skid turn. | x | x | x | x | x | x |
| LO | Describe the construction and principles of operation of a Turn Co-ordinator (or Turn and Bank Indicator). | x | x | x | x | x | x |
| LO | Compare the rate of turn indicator and the turn co-ordinator. | x | x | x | x | x | x |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **022 04 03 00** | **Attitude Indicator (Artificial Horizon)** | | | | | | |
| LO | Explain the purpose of the attitude indicator. | x | x | x | x | x | x |
| LO | Describe the different designs and principles of operation of attitude indicators (air driven, electric). | x | x | x | x | x | x |
| LO | State the degrees of freedom. | x | x | x | x | x | x |
| LO | Describe the gimbal system. | x | x | x | x | x | x |
| ~~LO~~ | ~~Describe the purpose and principles of operation of the following different erection systems:~~<br>~~- air driven artificial horizon,~~<br>~~- electric artificial horizon~~ | ~~x~~ | ~~x~~ | ~~x~~ | ~~x~~ | ~~x~~ | ~~x~~ |
| LO | Describe the effects, on the instrument indications, of aircraft acceleration and turns. | x | x | x | x | x | x |
| LO | Describe the attitude display and instrument markings. | x | x | x | x | x | x |
| LO | Explain the purpose of a vertical gyro unit. | x | x | x | x | x | x |
| LO | List and describe the following components of a vertical gyro unit:<br>- inputs: pitch and roll sensors<br>- transmission and amplification (synchros and amplifiers)<br>- outputs: display units such as Attitude Direction Indicator (ADI) , Auto Flight Control Systems. | x | x | x | x | x | x |
| LO | State the advantages and disadvantages of a vertical gyro unit compared to an attitude indicator with regard to:<br>- design (power source, weight and volume)<br>- accuracy of the information displayed,<br>- availability of the information for several systems (ADI, AFCS). | x | x | x | x | x | x |
| **022 04 04 00** | **Directional gyroscope** | | | | | | |
| LO | Explain the purpose of the directional gyroscope. | x | x | x | x | x | x |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Describe the following two types of directional gyroscopes:<br>- Air driven directional gyro<br>- Electric directional gyro. | x | x | x | x | x | x |
| LO | State the degrees of freedom. | x | x | x | x | x | x |
| LO | Describe the gimbal system. | x | x | x | x | x | x |
| LO | Define the following different errors:<br>- design and manufacturing imperfections (random wander)<br>- apparent wander (rotation of the earth)<br>- transport wander (movement relative to the earth's surface)<br>and explain their effects. | x | x | x | x | x | x |
| LO | Calculate the apparent wander (apparent drift rate in degrees per hour) of an uncompensated gyro according to latitude. | x | x | x | x | x | x |
| **022 04 05 00** | **Remote reading compass systems** | | | | | | |
| LO | Describe the principles of operation of a remote reading compass system. | x | x | x | x | x | x |
| LO | Using a block diagram, list and explain the function of the following components of a remote reading compass system:<br>- flux detection unit,<br>- gyro unit,<br>- transducers, precession amplifiers, annunciator<br>- display unit (compass card, synchronising and set heading knob, DG/compass switch). | x | x | x | x | x | x |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | State the advantages and disadvantages of a remote reading compass system compared to a direct reading magnetic compass with regard to:<br>- design (power source, weight and volume)<br>- deviation due to aircraft magnetism<br>- turning and acceleration errors<br>- attitude errors<br>- accuracy and stability of the information displayed,<br>- availability of the information for several systems (Compass card, RMI, AFCS). | x | x | x | x | x | x |
| **022 04 06 00** | **Solid-State Systems – AHRS (the following paragraph is to be introduced at a latter date)** | x | x | x | x | x | x |
| LO | State that the Micro Electro-Mechanical Sensors (MEMS) technology can be used to make:<br>- solid-state accelerometers,<br>- solid-state rate sensor gyroscopes,<br>- solid-state magnetometers (measurement of the earth magnetic field). | x | x | x | x | x | x |
| LO | Describe the basic principle of a solid-state Attitude and Heading Reference System system (AHRS) using a solid state 3-axis rate sensor, 3-axis accelerometer and a 3-axis magnetometer. | | | | | | |
| LO | Compare the solid state AHRS with the mechanical gyroscope and flux gate sytem with regard to:<br>- size and weight,<br>- accuracy,<br>- reliability<br>- cost. | | | | | | |
| **022 05 00 00** | **INERTIAL NAVIGATION AND REFERENCE SYSTEMS (INS and IRS)** | | | | | | |
| **022 05 01 00** | **INS: Inertial Navigation Systems (stabilised inertial platform)** | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **022 05 01 01** | **Basic principles** | | | | | | |
| LO | Explain the basic principles of inertial navigation. | x | | x | x | | |
| **022 05 01 02** | **Design** | | | | | | |
| LO | List and describe the main components of a stabilised inertial platform: | x | | x | x | | |
| LO | Explain the different corrections made to stabilise the platform. | x | | x | x | | |
| LO | List the following two effects that must be compensated for:<br>- Coriolis<br>- centrifugal. | x | | x | x | | |
| LO | Explain the alignment of the system, the different phases associated and the conditions required. | x | | x | x | | |
| LO | Explain the Schuler condition and give the value of the Schuler period. | x | | x | x | | |
| **022 05 01 03** | **Errors, accuracy** | | | | | | |
| LO | ~~Explain~~ State ~~the~~ that there are ~~following~~ three different types of errors:<br>- bounded errors,<br>- unbounded errors,<br>- other errors. | x | | x | x | | |
| LO | Give average values for bounded and unbounded errors according to time. | x | | x | x | | |
| LO | ~~Give~~ State that an average value for the position error of the ~~navigation system~~INS according to time is 1,5 Nm/hour or more. | x | | x | x | | |
| **022 05 01 04** | **Operation** | | | | | | |
| LO | Give examples of INS control and display panels. | x | | x | x | | |
| LO | Give an average value of alignment time, at mid-latitudes | x | | x | x | | |
| LO | List the outputs given by an INS. | x | | x | x | | |
| | ~~Cf MCQ 12774~~ | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Describe and explain the consequences concerning the loss of alignment by an Inertial Navigation System in flight | x | | x | x | | |
| **022 05 02 00** | **IRS: Inertial Reference Systems (Strapped-down)** | | | | | | |
| **022 05 02 01** | **Basic principles** | | | | | | |
| LO | Describe the operating principle of a strapped-down inertial reference system. | x | | x | x | | |
| LO | State the differences between a strapped-down inertial system (IRS) and a stabilised inertial platform (INS). | x | | x | x | | |
| **022 05 02 02** | **Design** | | | | | | |
| LO | List and describe the following main components of an IRS:<br>- rate sensors (laser gyros)<br>- inertial accelerometers<br>- high performance processors<br>- display unit | x | | x | x | | |
| LO | Explain the construction and operating principles of a Ring Laser Gyroscope (RLG) | x | | x | x | | |
| LO | Explain the different computations and corrections to be made to achieve data processing. | x | | x | x | | |
| LO | Explain the alignment of the system, the different phases associated and the conditions required. | x | | x | x | | |
| LO | Explain why the Schuler condition is still required. | x | | x | x | | |
| LO | Describe the “lock in” (laser lock) phenomena and the means of overcoming it. | x | | x | x | | |
| LO | State that an IRS can be a stand alone system or integrated with an ADC (ADIRU). | x | | x | x | | |
| **022 05 02 03** | **Errors, accuracy** | | | | | | |
| LO | Compare IRS and INS for errors and accuracy. | x | | x | x | | |
| **022 05 02 04** | **Operation** | | | | | | |
| LO | Compare IRS and INS, give recent examples of control panels. | x | | x | x | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List the outputs given by an IRS. | x | | x | x | | |
| LO | Give the advantages and disadvantages of an IRS compared to an INS. | x | | x | x | | |
| ~~LO~~ | ~~Explain why the output data of an IRS can be used as a source for an AHRS (Attitude and Heading Reference System).~~ | ~~x~~ | | ~~x~~ | ~~x~~ | | |
| **022 06 00 00** | **AEROPLANE : AUTOMATIC FLIGHT CONTROL SYSTEMS** | | | | | | |
| **022 06 01 00** | **General: Definitions and control loops.** | | | | | | |
| LO | State the following purposes of an Automatic Flight Control System (AFCS):<br>- enhancement of flight controls,<br>- reduction of pilot workload. | x | x | | | | |
| LO | Define and explain the following two functions of an AFCS:<br>- aircraft control: control of aeroplane movement about its CG.<br>- aircraft guidance: guidance of aeroplane CG (flight path). | x | x | | | | |
| LO | Define and explain: closed loop, open loop. | x | x | | | | |
| LO | Explain that the inner loop is for aircraft control and outer loop is for aircraft guidance. | x | x | | | | |
| LO | List the following different elements of a closed loop control system and explain their function:<br>- Input signal<br>- Error detector<br>- Signal processing (computation of output signal according to control laws)<br>- Output signal<br>- Control element<br>- Feedback signal | x | x | | | | |
| **022 06 02 00** | **Autopilot system: design and operation.** | | | | | | |
| LO | Define the three basic control channels. | x | x | | | | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List the following different types of autopilot systems : 1 axis, 2 axis and 3 axis. | x | x | | | | |
| LO | List and describe the main components of an autopilot system. | x | x | | | | |
| LO | Explain and describe the following lateral modes : Roll, Heading, VOR/LOC, NAV or LNAV. | x | x | | | | |
| LO | Describe the purpose of control laws for pitch and roll modes. | x | x | | | | |
| LO | Explain and describe the following longitudinal (or vertical) modes : Pitch, Vertical speed, Level Change, Altitude hold (ALT), Profile or VNAV, G/S. | x | x | | | | |
| LO | Give basic examples for pitch and roll channels of inner loops and outer loops with the help of a schematic diagram. | x | x | | | | |
| LO | ~~Discuss and e~~Explain the influence of ~~a~~ gain variation on precision and stability. | x | x | | | | |
| ~~LO~~ | ~~Explain how precision and stability can be achieved.~~ | ~~x~~ | ~~x~~ | | | | |
| LO | Explain gain adaptation, with regard to speed, configuration or flight phase. | x | x | | | | |
| LO | Explain and describe the following common (or mixed) modes : Take off, Go around and Approach<br>*Remark: The landing sequence is studied in 022 06 04 00.* | x | x | | | | |
| LO | List the different types of actuation configuration and compare their advantages/disadvantages. | x | x | | | | |
| LO | List the inputs and the outputs of a three-axis autopilot system. | x | x | | | | |
| LO | Describe and explain the synchronisation function. | x | x | | | | |
| LO | Give examples of engagement and disengagement systems and conditions. | x | x | | | | |
| LO | Define the Control Wheel Steering mode (CWS) according to CS 25 (see AMC 25.1329 § 4.3). | x | x | | | | |
| LO | Describe the Control Wheel Steering (CWS) mode operation. | x | x | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Describe with the help of a control panel of an autopilot system and a flight mode annunciator/indicator the actions and the checks performed by a pilot through a complete sequence:<br>- from Heading selection (HDG) to VOR/LOC captureguidance (arm/capture/track)?<br>- from Altitude selection (LVL Change) to Altitude capture hold (ALT), (arm/intercept/hold) | x | x | | | | |
| LO | Describe and explain the different phases and the associated annunciations/indications from level change to altitude capture and from heading mode to VOR/LOC capture. | x | x | | | | |
| LO | Describe and explain the existence of operational limits for lateral modes (LOC capture) with regard to speed/angle of interception/distance to threshold as for longitudinal modes (ALT or G/S capture) with regard to V/S. | x | x | | | | |
| **022 06 03 00** | **Flight Director: design and operation.** | | | | | | |
| LO | State the purpose of a Flight Director (FD) system. | x | x | | | | |
| LO | List and describe the main components of an FD system. | x | x | | | | |
| LO | List the different types of display. | x | x | | | | |
| LO | State Explain the differences between a FD system and an Autopilot system. and explain how each can be used independently. | x | x | | | | |
| LO | Explain how an FD and an AP can be used independently (together, separately (AP with no FD or FD with no AP) or neithernone of them of them.) | x | x | | | | |
| LO | Give examples of different situations with the respective indications of the command bars. | x | x | | | | |
| **022 06 04 00** | **Aeroplane: Flight Mode Annunciatior (FMA)** | | | | | | |
| LO | Explain the purpose and the importance of the FMA. | x | x | | | | |
| LO | State that the FMA provides:<br>- AFCS lateral and vertical modes<br>- Auto-throttle modes<br>- FD selection, AP engagement and automatic landing capacity<br>- Failure and alert messages. | x | x | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **022 06 05 00** | **Autoland: design and operation** | | | | | | |
| LO | Explain the purpose of an autoland system. | x | | | | | |
| LO | List and describe the main components of an autoland system. | x | | | | | |
| LO | Define the following terms:<br>- "fail passive"<br>- "fail operational" (fail active) systems<br>- alert height<br>according to CS-AWO. | x | | | | | |
| LO | Describe and explain the autoland sequence and the associated annunciations/indications from initial approach to roll-out (AP disengagement) or go-around. | x | | | | | |
| LO | List and explain the operational limitations to perform an autoland. | x | | | | | |
| **022 07 00 00** | **HELICOPTER: AUTOMATIC FLIGHT CONTROL SYSTEMS** | | | | | | |
| **022 07 01 00** | **General principles** | | | | | | |
| **022 07 01 01** | **Stabilisation** | | | | | | |
| LO | Explain the similarities and differences between SAS and AFCS the latter can actually fly the helicopter to perform certain functions selected by the pilot. Some AFCS's just have altitude and heading hold whilst others, include a vertical speed or IAS hold mode, where a constant rate of climb/decent or IAS is maintained by the AFCS. | | | x | x | x | |
| **022 07 01 02** | **Reduction of pilot work load** | | | | | | |
| LO | Appreciate how effective the AFCS is in reducing pilot work load by improving basic aircraft control harmony and decreasing disturbances. | | | x | x | x | |
| **022 07 01 03** | **Enhancement of helicopter capability** | | | | | | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Explain how an AFCS improves helicopter flight safety during:<br>- search and rescue because of increased capabilities<br>- flight by sole reference to instruments<br>- under slung load operations<br>- white out conditions in snow covered landscapes<br>- an approach to land with lack of visual cues | | | x | x | x | |
| LO | Explain that the Search and Rescue (SAR) modes of AFCS include the following functions:<br>- ability to auto hover,<br>- automatically transition down from cruise to a predetermined point or over-flown point<br>- ability for the rear crew to move the helicopter around in the hover,<br>- the ability to automatically transition back from the hover to cruise flight<br>- the ability to fly various search patterns. | | | x | x | x | |
| LO | Explain that the earlier auto-hover systems use doppler velocity sensors and the later systems use inertial sensors plus GPS and normally include a 2-dimensional hover velocity indicator for the pilots. | | | x | x | x | |
| LO | Explain why some SAR helicopters have both radio-altimeter height hold as well as barometric altitude hold. | | | x | x | x | |
| **022 07 01 04** | **Failures** | | | | | | |
| LO | Explain the various redundancies and independent systems that are built into the AFCS's. | | | x | x | x | |
| LO | Appreciate that the pilot can override the system in the event of a failure. | | | x | x | x | |
| LO | Explain a series actuator 'hard over' which equals aircraft attitude runaway. | | | x | x | x | |
| LO | Explain the consequences of a saturation of the series actuators. | | | x | x | x | |
| **022 07 02 00** | **Components – Operation** | | | | | | |
| **022 07 02 01** | **Basic sensors** | | | | | | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Explain the basic sensors in the system and their functions. | | | x | x | x | |
| LO | Explain that the number of sensors will be dependant on how many couple modes are in the system. | | | x | x | x | |
| **022 07 02 02** | **Specific sensors** | | | | | | |
| LO | Explain the function of the micro switches and strain gauges in the system which sense pilot input to prevent excessive feed back forces from the system. | | | x | x | x | |
| **022 07 02 03** | **Actuators** | | | | | | |
| LO | Explain the principles of operation of the series and parallel actuators, spring box clutches and the auto trim system. | | | x | x | x | |
| LO | Explain the principle of operation of the electronic hydraulic actuators in the system | | | x | x | x | |
| **022 07 02 04** | **Pilot/System interface: control panels, system indication, warnings** | | | | | | |
| LO | Describe the typical layout of the AFCS control panel. | | | x | x | x | |
| LO | Describe the system indications and warnings. | | | x | x | x | |
| **022 07 02 05** | **Operation** | | | | | | |
| LO | Explain the functions of the redundant sensors simplex and duplex channels (single/dual channel) | | | x | x | x | |
| **022 07 03 00** | **Stability Augmentation System (SAS)** | | | | | | |
| **022 07 03 01** | **General principles and operation** | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Explain the general principles and operation of a Stability Augmentation System related to:<br>- Rate damping<br>- Short term attitude hold<br>- Effect on Static stability<br>- Effect on Dynamic stability<br>- Aerodynamic Cross coupling<br>- Effect on Manoeuvrability<br>- Control response<br>- Engagement/disengagement<br>- Authority | | | x | x | x | |
| LO | Explain and describe the general working principles and primary use of SAS by damping pitch, roll and yaw motions. | | | x | x | x | |
| LO | Describe a simple SAS with forced trim system, which uses magnetic clutch and springs to hold cyclic control in the position where it was last released. | | | x | x | x | |
| LO | Explain the interaction of trim with SAS/SCAS (Stability and Control Augmentation System). | | | x | x | x | |
| LO | Appreciate that the system can be overridden by the pilot and individual channels deselected. | | | x | x | x | |
| LO | Describe the operational limits of the system. | | | x | x | x | |
| LO | Explain why the system should be turned off in severe turbulence or when extreme flight attitudes are reached. | | | x | x | x | |
| LO | Explain the safety design features built into some SAS's to limit the authority of the actuators to 10% to 20% of full control throw, to allow the pilot to override if actuators demand an unsafe control input. | | | x | x | x | |
| LO | Explain how cross coupling produces an adverse affect roll to yaw coupling, when the helicopter is subject to gusts. | | | x | x | x | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Explain the collective to pitch coupling, side slip to pitch coupling and inter axis coupling. | | | x | x | x | |
| **022 07 04 00** | **Autopilot – Automatic Stability Equipment** | | | | | | |
| **022 07 04 01** | **General principles** | | | | | | |
| LO | Explain the general auto-pilot principles related to:<br>- long term attitude hold<br>- fly through<br>- changing the reference (beep trim, trim release) | | | x | x | x | |
| **022 07 04 02** | **Basic modes (three axes/four axes)** | | | | | | |
| LO | Explain the AFCS operation on cyclic axes (pitch/roll), yaw axis, collective (fourth axis). | | | x | x | x | |
| **022 07 04 03** | **Automatic guidance (upper modes of AFCS)** | | | | | | |
| LO | Explain the function of the attitude hold system in an AFCS. | | | x | x | x | |
| LO | Explain the function of the heading hold system in an AFCS. | | | x | x | x | |
| LO | Explain the function of the vertical speed hold system in an AFCS. | | | x | x | x | |
| LO | Explain the function of the navigation coupling system in an AFCS. | | | x | x | x | |
| LO | Explain the function of the VOR/ILS coupling system in an AFCS. | | | x | x | x | |
| LO | Explain the function of the hover mode system in an AFCS (including Doppler and rad alt systems). | | | x | x | x | |
| LO | Explain the function of the SAR mode (Automatic transition to hover and back to cruise) in an AFCS. | | | x | x | x | |
| **022 07 04 04** | **Flight director: design and operation** | | | | | | |
| LO | Explain the purpose of a flight director (FD) system. | | | x | x | x | |
| LO | List the different types of display. | | | x | x | x | |
| LO | State the difference between the FD system and the Autopilot system. Explain how each can be used independently. | | | x | x | x | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List and describe the main components of a FD system. | | | x | x | x | |
| LO | Give examples of different situations with the respective indications of the command bars. | | | x | x | x | |
| LO | Explain the architecture of the different FD's fitted to helicopters and the importance to monitor other instruments as well as the Flight Director, because on some helicopter types which have the collective setting on the FD, there is no protection against a collective transmission overtorque. | | | x | x | x | |
| LO | Describe the collective setting and yaw depiction on FD for some helicopters | | | x | x | x | |
| **022 07 04 05** | **Automatic Flight Control Panel (AFCP)** | | | | | | |
| LO | Explain the purpose and the importance of the AFCP. | | | x | x | x | |
| LO | State that the AFCP provides:<br>- AFCS basic and upper modes<br>- FD selection, SAS and AP engagement<br>- Failure and alert messages. | | | x | x | x | |
| **022 08 00 00** | **TRIMS – YAW DAMPER – FLIGHT ENVELOPE PROTECTION** | | | | | | |
| **022 08 01 00** | **Trim systems : design and operation.** | | | | | | |
| LO | Explain the purpose of the trim system. | x | x | | | | |
| LO | State the existence of a trim system for each of the three axis. | x | x | | | | |
| LO | ~~Describe~~ Give example of~~the~~ trim indicators and their function. | x | x | | | | |
| LO | Describe and explain an automatic pitch trim system for a conventional aeroplane. | x | x | | | | |
| LO | Describe and explain an automatic pitch trim system for a fly-by-wire aeroplane. | x | | | | | |
| LO | State that for a fly-by-wire aeroplane the automatic pitch trim system operates also during manual flight. | x | | | | | |
| LO | Describe the consequences of manual operation of the trim wheel when the automatic pitch trim system is engaged. | x | x | | | | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Describe and explain engagement and disengagement conditions of the autopilot according to trim controls. | x | x | | | | |
| LO | Define Mach trim and state that the Mach trim system can be an independent system. | x | x | | | | |
| LO | State that for a fly-by-wire aeroplane an auto-trim system can be available for each of the three axis.<br>*Remark: For Fly-by-wire LOs, refer to reference 21.5.4.0* | x | x | | | | |
| **022 08 02 00** | **Yaw damper : design and operation.** | | | | | | |
| LO | Explain the purpose of the Yaw Damper system. | x | x | | | | |
| LO | List and describe the main components of a yaw damper system. | x | x | | | | |
| LO | Explain the purpose of the D~~d~~utch roll filter (filtering of the yaw input signal)~~ and why it is a narrow band pass filter.~~. | x | x | | | | |
| LO | Explain the the operation of a yaw damper system and state the difference between a 3-axis autopilot operation on the rudder channel. | x | x | | | | |
| **022 08 03 00** | **Flight envelope protection (FEP)** | | | | | | |
| LO | Explain the purpose of the FEP~~ function~~. | x | | | | | |
| LO | List the input parameters of the FEP~~ function~~. | x | | | | | |
| LO | Explain ~~and give examples of reversion modes~~the following functions ~~ with respect to the~~of the FEP~~ function~~:<br>- stall protection<br>- overspeed protection<br>~~- etc.….~~ | x | | | | | |
| LO | State that the stall protection function and the overspeed protection function apply to both mechanical/conventionnal and fly-by-wire control systems but other functions (e.g. pitch or bank limitation) can only apply to fly-by-wire control systems. | x | | | | | |
| **022 09 00 00** | **AUTOTHROTTLE – AUTOMATIC THRUST CONTROL SYSTEM** | | | | | | |
| LO | State the purpose of the auto-throttle (AT) system. | x | | | | | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Reprendre des LO identiques à l'auto-brake (armed/active/disconnected) | | | | | | |
| LO | Explain the operation of an AT system for the following modes:<br>- Take off/Go around<br>- Climb or Maximum Continuous Thrust (MCT): N1 or EPR targeted<br>- Speed<br>- Idle thrust<br>- Landing ("Flare" or "Retard") | x | | | | | |
| LO | Describe the control loop of an AT system, with regard to:<br>- Inputs: mode selection unit and switches (disengagement and engagement: TO-GA switches), radio altitude, air/ground logic switches.<br>- Error detection: comparison between reference values (N1 or EPR, speed) and actual values.<br>- Signal processing (control laws of the thrust lever displacement according to error signal)<br>- Ouputs: AT servo actuator<br>- Feedback: Thrust Lever Angle (TLA), data from ADC (TAS, Mach number), engine parameters (N1 or EPR). | x | | | | | |
| LO | State the existence of AT systems where thrust modes are determined by the lever position (no thrust mode panel or thrust rating panel, no TOGA switches). | x | | | | | |
| LO | Explain the limitations of an AT system in case of turbulence. | x | | | | | |
| **022 10 00 00** | **COMMUNICATION SYSTEMS** | | | | | | |
| **022 10 01 00** | **Voice communication, Datalink transmission.** | | | | | | |
| **022 10 01 01** | **Definitions and Transmission modes.** | | | | | | |
| LO | State the purpose of a datalink transmission system. | x | | | | | |
| LO | Compare voice communication versus datalink transmission systems. | x | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | State that VHF, HF and SATCOM devices can be used for voice communication and datalink transmission: | x | | | | | |
| LO | State the advantages and disadvantages of each transmission mode with regard to:<br>- range,<br>- line of sight limitations,<br>- quality of the signal received,<br>- interference due to ionospheric conditions<br>- data transmission speed. | x | | | | | |
| LO | State that the satellite communication networks do not cover extreme polar regions. | x | | | | | |
| LO | Define downlink and uplink communications. | x | | | | | |
| LO | State that a D-ATIS is an ATIS message received by datalink. | x | | | | | |
| **022 10 01 02** | **Systems: Architecture, design and operation** | | | | | | |
| LO | Name the two following datalink service providers:<br>- SITA<br>- ARINC<br>and state their function. | x | | | | | |
| LO | Describe the ACARS network. | x | | | | | |
| LO | Describe the two following systems using the VHF/HF/Satcom datalink transmission:<br>- ACARS (Aircraft Communication Addressing and Reporting System,<br>- ATSU (Air Traffic Service Unit). | x | | | | | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List and describe the following possible on-board components of an ATSU:<br>- Communications Management Unit (VHF/HF/SATCOM)<br>- Data Communication Display Unit (DCDU)<br>- Multi Control Display Unit (MCDU) for AOC, ATC and messages from the crew (downlink communication)<br>- ATC message visual warning<br>- Printer | x | | | | | |
| LO | Give examples of Airline Operations Communications (AOC) datalink messages such as:<br>- OOOI (Out of the gate, Off the ground, On the ground, Into the gate)<br>- Load-sheet<br>- Passenger information (connecting flights)<br>- Weather reports (METAR, TAF)<br>- Maintenance reports (engine exceedances)<br>- Free text messages | x | | | | | |
| LO | Give examples of Air Traffic Communications (ATC) datalink messages such as:<br>- Departure clearance<br>- Oceanic clearance | x | | | | | |
| **022 10 02 00** | **Future Air Navigation Systems (FANS)** | | | | | | |
| LO | State the existence of the ICAO CNS/ATM concept (Communication, Navigation, Surveillance/ Air Traffic Management). | x | | | | | |
| LO | Define and explain the FANS concept (including FANS A and FANS B). | x | | | | | |
| LO | State that FANS A uses the ACARS network. | x | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List and explain the following FANS A applications:<br>- AFN (ATS Facility Notification)<br>- ADS (Automatic Dependant Surveillance),<br>- CPDLC (Controller Pilot Data Link Communications) | x | | | | | |
| LO | Compare the ADS application with the Secondary Surveillance Radar function and the CPDLC application with VHF communication systems. | x | | | | | |
| LO | State that an ATC Centre can use the ADS application only, or the CPDLC application only or both of them (not including AFN). | x | | | | | |
| LO | Describe a notification phase (LOG ON) and state its purpose. | x | | | | | |
| LO | List the different types of messages of the CPDLC function and give examples of CPDLC datalink messages. | x | | | | | |
| LO | List the different types of ADS contracts:<br>- periodic<br>- on demand<br>- on event.<br>- emergency mode | x | | | | | |
| LO | State that the controller can modify the ‘periodic’, ‘on demand’ and ‘on event’ contracts or the parameters of these contracts (optional data groups) and that these modifications do not require crew notification. | x | | | | | |
| LO | Describe the ‘emergency mode’. | x | | | | | |
| **022 11 00 00** | **FLIGHT MANAGEMENT SYSTEM (F.M.S.)** | | | | | | |
| LO | *Remark: The use of a FMS as a navigation system is detailed in Radio Navigation (062), reference 062 05 04 00.* | | | | | | |
| **022 11 01 00** | **Design.** | | | | | | |
| LO | State the purpose of a Flight Management System (FMS). | x | | x | x | | |
| LO | Describe a typical dual FMS architecture. | x | | x | x | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Describe the different possible configuration of this architecture during degraded modes of operation. | x | | x | x | | |
| LO | List the possible inputs and outputs of an FMS<br>*Remark: No standard of FMS can be given, because the FMS is type related to an aircraft manufacturer and the FMS standard is defined by the airline customer.* | x | | x | x | | |
| LO | Describe the interfaces of the FMS with AFCS | x | | x | x | | |
| LO | Describe the interfaces of the FMS with the AT system. | x | | | | | |
| **022 11 02 00** | **Navigation data base, aircraft data base** | | | | | | |
| LO | Describe the contents and the main features of the navigation database and of the aircraft data base : read only information, updating cycle. | x | | x | x | | |
| LO | Define and explain the performance factor. | x | | x | x | | |
| **022 11 03 00** | **Operations, limitations.** | | | | | | |
| LO | List and describe data computation and functions including position computations (multi-sensors), flight management, lateral/vertical navigation and guidance. | x | | x | x | | |
| LO | State the difference between computations based on measured data (use of sensors) and computations based on database information and give examples. | x | | x | x | | |
| LO | Define and explain the Cost Index (CI). | x | | | | | |
| LO | Describe navigation accuracy computations and approach capability, degraded modes of operation : back up navigation, use of raw data to confirm position/RAIM function for RNAV procedures. | x | | x | x | | |
| LO | Describe fuel computations with standard and non-standard configurations including one-engine out, landing gear down, flaps, spoilers, use of the anti-ice system, increase of consumption due to a MEL/CDL item, etc. | x | | x | x | | |
| LO | Describe automatic radio navigation and tuning (Comm, Nav). | x | | x | x | | |
| **022 11 04 00** | **Man Machine Interface (Multi-Function Control Display Unit: MCDU)** | | | | | | |
| LO | Give examples and describe the basic functions of the Man Machine Interface (MCDU) | x | | x | x | | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **022 12 00 00** | **ALERTING SYSTEMS, PROXIMITY SYSTEMS** | | | | | | |
| **022 12 01 00** | **General** | | | | | | |
| LO | State definitions, category, criteria and alerting systems characteristics according to CS 25/AMJ 25.1322 for aeroplanes and CS 29 for helicopters as appropriate. | x | x | x | x | x | |
| **022 12 02 00** | **Flight Warning Systems** | | | | | | |
| LO | State the purpose of a FWS and list the typical sources (abnormal situations) of a warning and/or an alert. | x | | x | x | x | |
| LO | List the main components of a FWS. | x | | x | x | x | |
| **022 12 03 00** | **Stall Warning Systems (SWS)** | | | | | | |
| LO | State the function of a SWS. | x | x | | | | |
| LO | State the characteristics of a SWS according to CS 25.207 (c). | x | x | | | | |
| LO | List the different types of stall warning systems. | x | x | | | | |
| LO | List the main components of a SWS. | x | x | | | | |
| LO | List the inputs and the outputs of a SWS. | x | x | | | | |
| **022 12 04 00** | **Stall protection** | | | | | | |
| LO | State the function of a stall protection system. | x | | | | | |
| LO | List the different types of stall protection systems including the difference between mechanical and fly-by-wire controls. | x | | | | | |
| LO | List the main components of a stall protection system. | x | | | | | |
| LO | List the inputs and the outputs of a stall protection system. | x | | | | | |
| LO | Explain the difference between a stall warning system and a stall protection system. | x | | | | | |
| **022 12 05 00** | **Overspeed warning** | | | | | | |
| LO | Explain the purpose of an overspeed warning system (VMO/MMO pointer) | x | x | | | | |
| LO | Explain the design of a mechanical VMO/MMO pointer | x | x | | | | |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | State that for large aeroplanes, an aural warning must be associated to the overspeed warning if an electronic display is used (see AMC 25.11 § 10.b.(2) p 2-GEN-22). | x | x | | | | |
| LO | Give examples of VMO/MMO pointer: barber pole pointer, barber pole vertical scale. | x | x | | | | |
| **022 12 06 00** | **Take-off warning** | | | | | | |
| LO | State the purpose of a Take-off warning system and list typical abnormal situations generating a warning. (see AMC 25.703 § 4 and § 5) | x | | | | | |
| **022 12 07 00** | **Altitude alert system** | | | | | | |
| LO | State the function and describe an Altitude alert system. | x | x | x | x | x | x |
| LO | List and describe the different types of displays and possible alerts. | x | x | x | x | x | x |
| **022 12 08 00** | **Radio-altimeter** | | | | | | |
| LO | State the function of a low altitude radio-altimeter. | x | x | x | x | x | x |
| LO | Describe the principle of the distance (height) measurement. | x | x | x | x | x | x |
| LO | State the bandwidth and frequency range used. | x | x | x | x | x | x |
| LO | List the different components of a radio-altimeter and describe the different types of displays. | x | x | x | x | x | x |
| LO | List the systems using the radio-altimeter information. | x | x | x | x | x | x |
| LO | State the range and accuracy of a radio-altimeter. | x | x | x | x | x | x |
| LO | Describe and explain the cable length compensation. | x | x | x | x | x | x |
| **022 12 09 00** | **Ground proximity warning systems (GPWS)** | | | | | | |
| **022 12 09 01** | **GPWS: design, operation, indications** | | | | | | |
| LO | State the purpose of a ground proximity warning system (GPWS). | x | | x | x | | |
| LO | List the components of GPWS. | x | | x | x | | |
| LO | List the inputs and the outputs of a GPWS. | x | | x | x | | |
| LO | List and describe the different modes of operation of a GPWS. | x | | x | x | | |

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|---|---|---|---|---|---|---|---|
| **022 12 09 02** | **Terrain Avoidance Warning System (TAWS), other name: Enhanced GPWS (EGPWS) :** | | | | | | |
| LO | State the purpose of a Terrain Avoidance Warning System (TAWS) for aeroplanes and HTAWS for helicopters and explain the difference from a GPWS. | x | | x | x | | |
| LO | List the components of TAWS/HTAWS. | x | | x | x | | |
| LO | List the inputs and the outputs of a TAWS/HTAWS. | x | | x | x | | |
| LO | Give examples of terrain displays and list the different possible alerts. | x | | x | x | | |
| LO | Give examples of time response left to the pilot according to look-ahead distance, speed and aircraft performances. | x | | x | x | | |
| LO | Explain why the TAWS/HTAWS must be coupled to a precise position sensor.. | x | | x | x | | |
| **022 12 09 03** | **Runway Awareness and Advisory System** (To be introduced at a later date.) | | | | | | |
| LO | Explain that a Runway Awareness and Advisory System is a software upgrade of the existing TAWS (EGPWS) to reduce runway incursions. | (x) | | | | | |
| **022 12 10 00** | **ACAS/TCAS principles and operations** | x | x | x | x | x | x |
| LO | State that ACAS II is an ICAO standard for anti collision purposes | x | x | x | x | x | x |
| LO | State that TCAS II version 7 is compliant with ACAS II standard. | x | x | x | x | x | x |
| LO | Explain that ACAS II is an anti-collision system and does not guarantee any specific separation. | x | x | x | x | x | x |
| LO | Describe the purpose of an ACAS II system as an anti-collision system. | x | x | x | x | x | x |
| LO | Define a Resolution Advisory (RA) and a Traffic Advisory (TA) | x | x | x | x | x | x |
| LO | State that resolution advisories are calculated in the vertical plane only (climb or descent). | x | x | x | x | x | x |
| LO | Explain the difference between a corrective RA and a preventive RA (no modification of vertical speed) | x | x | x | x | x | x |
| LO | Explain that if two aircraft are fitted with an ACAS II, the RA will be co-ordinated. | x | x | x | x | x | x |
| LO | State that ACAS II equipment can take into account several threats simultaneously | x | x | x | x | x | x |

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|---|---|---|---|---|---|---|---|
| LO | State that a detected aircraft without altitude reporting can only generate a Traffic Advisory. | x | x | x | x | x | x |
| LO | Describe the TCAS II system in relation to:<br>- Antenna used.<br>- Computer and links with radio altimeter, air data computer and mode S transponder | x | x | x | x | x | x |
| LO | Identify the inputs and outputs of TCAS II | x | x | x | x | x | x |
| LO | Explain the principle of TCAS II interrogations: | x | x | x | x | x | x |
| LO | State that standard detection range is approximately 30 NM. | x | x | x | x | x | x |
| LO | State that the normal interrogation period is 1 second | x | x | x | x | x | x |
| LO | Explain the principle of "reduced surveillance" | x | x | x | x | x | x |
| LO | Explain that in high density traffic areas the period can be extended to 5 seconds and the transmission power reduction can reduce the range detection down to 5 NM | x | x | x | x | x | x |
| LO | Identify the equipment, which an intruder must be fitted with in order to be detected by TCAS II. | x | x | x | x | x | x |

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|---|---|---|---|---|---|---|---|
| LO | Explain the anti collision process:<br>- that the criteria used to trigger an alarm (TA or RA) are the time to reach the Closest Point of Approach, called TAU, and the difference of altitude.<br>- that an intruder will be classified as Proximate when being less than 6 NM and 1200 ft from the TCAS equipped aircraft<br>- that the limit time to CPA is different depending on aircraft altitude, linked to a sensitivity level (SL) and state that the value to trigger a RA is from 15 to 35 seconds.<br>- that, in case of RA, the intended vertical separation varies from 300 to 600 ft ( 700 ft above FL420 ), depending on the SL<br>- that below 1000 ft above ground, no RA can be generated.<br>- that below 1450 ft (radio altimeter value) "Increase descent" RA is inhibited.<br>- that, in high altitude, performances of the type of aircraft are taken in account to inhibit "Climb" and "Increase Climb" RA | x | x | x | x | x | x |
| LO | List and interpret the following information available from TCAS:<br>- the different possible status for a detected aircraft: other, proximate, intruder.<br>- the appropriate graphic symbols and their position on the horizontal display.<br>- different aural warnings. | x | x | x | x | x | x |
| LO | Explain that a RA is presented as a possible vertical speed, on a TCAS indicator or on the Primary Flight Display | x | x | x | x | x | x |
| LO | Describe the possible presentation of a RA, on a VSI or on PFD | x | x | x | x | x | x |
| LO | Explain that the pilot must not interpret the horizontal track of an intruder upon the display | x | x | x | x | x | x |
| **022 12 11 00** | **Rotor/engine overspeed alert system** | | | | | | |
| **022 12 11 01** | **Design, operation, displays, alarms** | | | | | | |
| LO | Describe the basic design principles, operation, displays and warning/alarm systems fitted to different helicopters. | | | x | x | x | |
| **022 13 00 00** | **INTEGRATED INSTRUMENTS – ELECTRONIC DISPLAYS** | | | | | | |

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|---|---|---|---|---|---|---|---|
| **022 13 01 00** | **Electronic display units** | | | | | | |
| **022 13 01 01** | **Design, limitations** | | | | | | |
| LO | List the different technologies used eg CRT and LCD and the associated limitations:<br>- cockpit temperature<br>- glare | x | x | x | x | x | x |
| **022 13 02 00** | **Mechanical Integrated instruments : ADI/HSI** | | | | | | |
| LO | Describe an Attitude and Director Indicator (ADI) and a Horizontal Situation Indicator (HSI). | x | x | x | x | x | x |
| LO | List all the information that can be displayed for either instruments . | x | x | x | x | x | x |
| **022 13 03 00** | **Electronic Flight Instrument Systems (EFIS)** | | | | | | |
| | *Remarks:*<br>*1 - The use of EFIS as navigation display system is also detailed in Radio Navigation (062), reference 062 05 05 02 (EFIS instruments)*<br>*2 - reference to AMC 25-1322 can be used for aeroplanes only.-* | | | | | | |
| **022 13 03 01** | **Design, operation** | | | | | | |
| LO | List and describe the different components of an EFIS. | x | x | x | x | x | x |
| LO | List the following possible inputs and outputs of an EFIS:<br>- control panel,<br>- display units,<br>- symbol generator,<br>- remote light sensor | x | x | x | x | x | x |
| LO | Describe the function of the symbol generator unit. | x | x | x | x | x | x |
| ~~LO~~ | ~~State that colors ….AMC 25-11. Attention applicabilité Hélicoptère non garantie!~~ | ~~x~~ | ~~x~~ | ~~x~~ | ~~x~~ | ~~x~~ | ~~x~~ |
| **022 13 03 02** | **Primary Flight Display (PFD), Electronic Attitude Director Indicator (EADI).** | | | | | | |

LO

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|---|---|---|---|---|---|---|---|
| LO | State that a PFD (or an EADI) presents a dynamic color display of all the parameters necessary to control the aircraft. | x | x | x | x | x | x |
| LO | List and describe the following information that can be displayed on the Primary Flight Display (PFD) unit of an aircraft:<br>- Flight Mode Annunciation<br>- basic T:<br>  - attitude<br>  - IAS<br>  - altitude<br>  - heading/track indications<br>- vertical speed<br>- maximum airspeed warning<br>- selected airspeed<br>- speed trend vector<br>- selected altitude<br>- current barometric reference<br>- steering indications (FD command bars)<br>- selected heading<br>- Flight Path Vector (FPV)<br>- Radio altitude<br>- Decision height<br>- ILS indications<br>- ACAS (TCAS) indications<br>- failure flags and messages. | x | x | x | x | x | x |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List and describe the following information that can also be displayed on the Primary Flight Display (PFD) unit of an aeroplane:<br>- Take off and landing reference speeds<br>- minimum airspeed<br>- lower selectable airspeed<br>- Mach number | x | | | | | |
| **022 13 03 03** | **Navigation Display (ND), Electronic Horizontal Situation Indicator (EHSI).** | | | | | | |
| LO | State that a ND (or a EHSI) provides a mode-selectable color flight navigation display. | x | x | x | x | x | x |
| LO | List and describe the following four modes displayed on a Navigation Display (ND) unit:<br>- MAP (or ARC):<br>- VOR (or ROSE VOR)<br>- APP (or ROSE LS)<br>- PLAN | x | x | x | x | x | x |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List and explain the following information that can be displayed with the MAP (or ARC) mode on a Navigation Display (ND) unit:<br>- selected and current track,<br>- selected and current heading (magnetic or true north reference),<br>- cross track error,<br>- origin and destination airport with runway selected<br>- bearings To or From the tuned and selected stations<br>- active and/or secondary flight plan<br>- range marks<br>- ground speed<br>- TAS and Ground Speed<br>- wind direction and speed<br>- next waypoint distance and estimated time of arrival<br>- additional navigation facilities (STA), waypoint (WPT) and airports (ARPT)<br>- weather radar information<br>- traffic information from the ACAS (TCAS).<br>- terrain information from the TAWS or HTAWS (EGPWS).<br>- failure flags and messages. | x | x | x | x | x | x |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List and explain the following information that can be displayed with the VOR/APP (or ROSE VOR/ROSE LS) mode on a Navigation Display (ND) unit:<br>- selected and current track,<br>- selected and current heading (magnetic or true north reference),<br>- VOR course or ILS localizer course.<br>- VOR (VOR or ROSE VOR mode) or LOC course deviation (APP or ROSE LS)<br>- Glide Slope pointer (APP or ROSE LS)<br>- Frequency or identifier of the tuned station.<br>- ground speed<br>- TAS and Ground Speed<br>- Wind direction and speed<br>- Failure flags and messages. | x | x | x | x | x | x |
| LO | List and explain the following information that can be displayed with the PLAN mode on a Navigation Display (ND) unit:<br>- selected and current track,<br>- origin and destination airport with runway selected<br>- active and/or secondary flight plan<br>- range marks<br>- ground speed<br>- TAS and Ground Speed<br>- wind direction and speed<br>- next waypoint distance and estimated time of arrival<br>- additional navigation facilities (STA), waypoint (WPT) and airports (ARPT)<br>- failure flags and messages. | x | x | | | | |
| LO | Give examples of possible transfers between units. | x | x | x | x | x | x |

LO

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Give examples of EFIS control panels. | x | x | x | x | x | x |
| **022 13 04 00** | **Engine parameters, Crew warnings, Aircraft systems, Procedure and Mission display systems** | | | | | | |
| LO | State the purpose of the following systems:<br>- engine instruments centralised display unit<br>- crew alerting system associated with an electronic check list display unit,<br>- aircraft systems display unit enables the display of normal and degraded modes of operation of the aircraft systems. | x | | x | x | | |
| LO | For each system, describe the architecture and give examples of display. | x | | x | x | | |
| LO | Give the following different names by which engine parameters, crew warnings,aircraft systems and procedures display systems are known:<br>- Multi Function Display Unit (MFDU),<br>- Engine Indication and Crew alerting systems (EICAS),<br>- Engine and Warning Display (EWD),<br>- Electronic Centralised Aircraft Monitor (ECAM.) | x | | | | | |
| LO | Give the names of the following different display systems and describe their main functions<br>- Vehicle Engine Monitoring Display (VEMD),<br>- Integrated Instruments Display System (IIDS) | | | x | x | | |
| LO | State the purpose of a mission display unit. | | | x | x | | |
| LO | For each system, describe the architecture and give examples of display. | | | x | x | | |
| **022 13 05 00** | **Engine First Limit Indicator** | | | | | | |
| LO | Describe the principles of design, operation and compare the different indications and displays available. | | | x | x | x | |
| LO | Describe what information can be displayed on the screen, when in the limited screen composite mode. | | | x | x | x | |

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|---|---|---|---|---|---|---|---|
| **022 13 06 00** | **Electronic Flight Bag (EFB) -** to be introduced at a later date | (x) | | | | | |
| **022 14 00 00** | **MAINTENANCE, MONITORING AND RECORDING SYSTEMS** | | | | | | |
| LO | State the basic technologies used for this equipment and its performances.<br>*Remark: No JAR-OPS knowledge is requested.* | | | | | | |
| **022 14 01 00** | **Cockpit voice recorder (CVR)** | | | | | | |
| LO | State the purpose of a Cockpit Voice Recorder | x | | | | | |
| LO | List the main components of a CVR:<br>- a shock resistant tape recorder associated with an underwater locating device<br>- an area microphone<br>- a control unit with the following controls: auto/on, test and erase and a headset jack; | x | | | | | |
| LO | List the following main parameters recorded on the CVR:<br>- voice communications transmitted from or received on the flight deck<br>- the aural environment of the flight deck<br>- voice communication of flight crew members using the aeroplane's interphone system<br>- voice or audio signals introduced into a headset or speaker<br>- voice communication of flight crew members using the public address system, when installed | x | | | | | |
| **022 14 02 00** | **Flight data recorders (FDR)** | | | | | | |
| LO | State the purpose of a Flight Data Recorder | x | | | | | |
| LO | List the main components of a FDR:<br>- a data interface and acquisition unit<br>- a recording system (digital flight data recorder)<br>- two control units (start sequence, event mark setting) | x | | | | | |

CHAPTER 19: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 022 – Aircraft General Knowledge - Instrumentation
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List the following main parameters recordedon the FDR:<br>- time or relative time count<br>- attitude (pitch and roll)<br>- airspeed<br>- pressure altitude<br>- heading<br>- normal acceleration<br>- propulsive/thrust power on each engine and cockpit thrust/power lever position if applicable<br>- flaps/slats configuration or cockpit selection<br>- ground spoilers and/or speed brake selection | x | | | | | |
| LO | State that additional parameters can be recorded according to FDR capacity and JAR-OPS requirements. | x | | | | | |
| **022 14 03 00** | **Maintenance and Monitoring systems** | | | | | | |
| **022 14 03 01** | **Helicopter Operations Monitoring Programme (HOMP): Design, operation, performance** | | | | | | |
| LO | Describe the Helicopter Operations Monitoring Programme (HOMP) as a helicopter version of aeroplane Flight Data Monitoring (FDM) programmes. | | | x | x | | |
| LO | State that the HOMP software consists of three integrated modules:<br>- Flight Data Events (FDE)<br>- Flight Data Measurements (FDM)<br>- Flight Data Traces (FDT) | | | x | x | | |
| LO | Describe and explain the information flow of HOMP. | | | x | x | | |
| LO | Describe HOMP Operation and Management Processes. | | | x | x | | |

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|---|---|---|---|---|---|---|---|
| **022 14 03 02** | **Integrated Health & Usage Monitoring System (IHUMS) : Design, operation, performance** | | | | | | |
| LO | Describe the main features of IHUMS :<br>- Rotor System Health<br>- Cockpit Voice / Flight Data Recorder<br>- Gearbox System Health<br>- Engine Health<br>- Exceedance Monitoring<br>- Usage Monitoring<br>- Transparent operation<br>- Ground Station Features<br>- Exceedance Monitoring<br>- Monitoring<br>- Gearbox Health<br>- Rotor Track & Balance<br>- Engine Performance Trending<br>- Usage Monitoring<br>- Quality Controlled to Level 2 | | | x | x | | |
| LO | Describe the Ground Station Features of IHUMS | | | x | x | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | Summarise the benefits of IHUMS including:<br>- Reduced risk of catastrophic failure of rotor or gearbox<br>- Improved rotor track & balance giving lower vibration levels<br>- Accurate recording of flight exceedances<br>- Cockpit Voice Recorder / Flight Data Recorder allows accurate accident / incident investigation & HOMP<br>- Maintenance Cost Savings | | | x | x | | |
| LO | State the benefits of IHUMS and HOMP | | | x | x | | |
| **022 14 03 03** | **Aeroplane Condition Monitoring System (ACMS): General, design, operation** | | | | | | |
| LO | State the purpose of an Aeroplane Condition Monitoring System (ACMS). | x | | | | | |
| LO | Describe the structure of an ACMS including:<br>- Inputs: aircraft systems (such as Air cond., Auto flight, flight controls, fuel, Landing gear, Navigation, Pneumatic, APU, Engine), MCDU<br>- Data Management unit<br>- Recording unit: digital recorder<br>- Outputs: printer, ACARS or ATSU | x | | | | | |
| LO | State that maintenance messages sent by an ACMS can be transmitted without crew notification. | x | | | | | |
| **022 15 00 00** | **DIGITAL CIRCUITS AND COMPUTERS** | | | | | | |
| **022 15 01 00** | **Digital circuits and computers: General, definitions and design.** | | | | | | |
| LO | Define a computer as a machine for manipulating data according to a list of instructions. | x | | x | x | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| LO | List the following main components of a stored-programme (“Von Neumann architecture”) basic computer:<br>- Central Processing Unit (CPU) including Arithmetic Logic Unit (ALU) and the control unit.<br>- Memory<br>- Input and output devices (peripherals)<br>and state their functions. | x | | x | x | | |
| LO | State the existence of the different buses and their function. | x | | x | x | | |
| LO | Define the terms ‘hardware’ and ‘software’. | x | | x | x | | |
| LO | Define and explain the terms ‘multitasking’ and ‘multiprocessing’. | x | | x | x | | |
| LO | With the help of the relevant 022 references, give examples of airborne computers, such as ADC, FMS, GPWS, etc. and list the possible peripheral equipment for each system. | x | | x | x | | |
| LO | Describe the principle of the following technologies used for memories :<br>- chip circuit<br>- magnetic disk<br>- optical disk | x | | x | x | | |
| **022 15 02 00** | **Software: General, definitions and certification specifications.** | | | | | | |
| **LO** | State the difference between assembly languages, high level languages and scripting languages. | x | | x | x | | |
| LO | Define the term ‘operating system’ (OS) and give different examples including airborne systems such as FMS or ATSU (for aeroplanes only). | x | | x | x | | |
| LO | State the existence of "Software Considerations in Airborne Systems and Equipment Certification" (see document referenced RTCA/DO-178B or EUROCAE ED-12B) | x | | x | x | | |
| LO | List the specific levels of safety criticality according to document EUROCAE ED-12B. | x | | x | x | | |

**END**