TRAINING PROGRAM (Sylabus) IN THE FIELD OF THEORETICAL KNOWLEDGE FOR ATPL(A) LICENSE

010. AIR LAW

INTERNATIONAL LAW: CONVENTIONS, AGREEMENTS AND ORGANISATIONS

The Convention on International Civil Aviation (Chicago) - ICAO Doc 7300/9. Convention on the High Seas (Geneva, 29 April 1958)

The establishment of the Convention on International Civil Aviation, Chicago, 7 December 1944

Explain the circumstances that led to the establishment of the Convention on International Civil Aviation, Chicago, 7 December 1944.

Source: ICAO Doc 7300/9 Preamble

Part I - Air navigation

Recall the general contents of relevant parts of the following chapters:
- general principles and application of the Convention;
-flight over territory of Contracting States;
- nationality of aircraft;
- international standards and recommended practices (SARPs), especially notification of differences and validity of endorsed certificates and licences.

Source: ICAO Doc 7300/9 Part 1, Articles 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 16, 17, 18, 19, 20, 37, 38, 39, 40

General principles. Describe the application of the following terms in civil aviation:
- sovereignty;
- territory and high seas according to the UN Convention on the High Seas.

Source: Convention on the High Seas (Geneva, 29 April 1958) Articles 1, 2; ICAO Doc 7300/9 Part 1, Articles 1, 2

Explain the following terms and how they apply to international air traffic:
- right of non-scheduled flight (including the two technical freedoms of the air);
- scheduled air services;
- cabotage;
- landing at customs airports;
- Rules of the Air;
- search of aircraft.

Source: ICAO Doc 7300/9, Articles 5, 6, 7, 10, 12, 16

Explain the duties of Contracting States in relation to:
- documents carried on board the aircraft:
- certificate of registration;
- certificates of airworthiness;
- licences of personnel;
- recognition of certificates and licences;
- cargo restrictions;
- photographic apparatus.

Source: ICAO Doc 7300/9, Articles 29, 31, 32, 33, 35, 36

Part II - The International Civil Aviation Organization (ICAO)

Describe the objectives of ICAO.

Source: ICAO Doc 7300/9, Article 44

Recognise the organisation and duties of the ICAO Assembly, Council and Air Navigation Commission (ANC).

Source: ICAO Doc 7300/9, Articles 48, 49, 50, 54, 56, 57

Describe the annexes to the Convention.

Source: ICAO Doc 7300/9, Articles 54, 90, 94, 95

Other conventions and agreements

The International Air Services Transit Agreement (ICAO Doc 7500)

Explain the two technical freedoms of the air.

Source: ICAO Doc 7500

The International Air Transport Agreement (ICAO Doc 9626)

Explain the three commercial freedoms of the air.

Source: ICAO Doc 9626

Suppression of Unlawful Acts Against the Safety of Civil Aviation - The Tokyo Convention of 1963

Describe the measures and actions to be taken by the pilot-in-command (PIC) of an aircraft in order to suppress unlawful acts against the safety of the aircraft.

Source: ICAO Doc 8364 — Convention on Offences and Certain Other Acts Committed on Board Aircraft, Tokyo, 14 September 1963 ***Private international law***

Explain the legal significance of the issue of a passenger ticket or of baggage/cargo documents (that the issue is a form of contract).
Source: ICAO Doc 9740 Convention for the Unification of Certain Rules for International Carriage — The Montreal Convention of 1999
Describe the consequences for an airline or the PIC when a document of carriage is not issued (that the contract is unaffected).
Source: ICAO Doc 9740 Convention for the Unification of Certain Rules for International Carriage — The Montreal Convention of 1999
Explain the consequences for an airline operator of Regulation (EC) No 261/2004 on passenger rights in the event of delay, cancellation or denial of boarding.
Source: Regulation (EC) No 261/2004
Explain the liability limit in relation to destruction, loss, damage or delay of baggage.
Source: ICAO Doc 9740 Convention for the Unification of Certain Rules for International Carriage — The Montreal Convention of 1999
World organisations
The International Air Transport Association (IATA)
Describe the objectives of IATA.
Source: IATA web page
European organisations
European Union Aviation Safety Agency (EASA) Regulation (EU) 2018/1139
Describe the objectives of EASA.
Describe the role of EASA in European civil aviation.
State that the structure of the regulatory material related to EASA involves: hard law (regulations, delegated acts, implementing acts, and implementing rules); soft law (certification specifications, acceptable means of compliance, and guidance material).
State the meaning of the terminology associated with the structure of the regulatory material related to EASA, specifically: regulations, delegated acts, implementing acts, and implementing rules, as applicable until 11 September 2023; and certification specifications, acceptable means of compliance, and guidance material.
EUROCONTROL
Describe the Single European Sky (SES) regulations.
AIRWORTHINESS OF AIRCRAFT, AIRCRAFT NATIONALITY AND REGISTRATION MARKS
Certificate of Airworthiness (CofA)
Certificate of Airworthiness (CofA) - Details
State the issuing authority of a CofA.
Source: ICAO Annex 8, Chapter 3.2 Issuance and continued validity of a Certificate of Airworthiness
State the necessity to hold a CofA.
Source: ICAO Doc 7300, Article 31
Explain the prerequisites for the issue of a CofA according to Commission Regulation (EU) No 748/2012.
Source: Commission Regulation (EU) No 748/2012, SUBPART H
State who shall determine an aircraft's continuing airworthiness.
Source: ICAO Annex 8, Chapter 3.2 Issuance and continued validity of a Certificate of Airworthiness
Describe how a CofA can be renewed or may remain valid.
Source: ICAO Annex 8 Chapter 3.2 Issuance and continued validity of a Certificate of Airworthiness; Chapter 3.5 Temporary loss of airworthiness; Chapter 3.6 Damage to aircraft
ICAO Annex 7 - Aircraft Nationality and Registration Marks
ICAO Annex 7 - Definitions
Recall the definition of the following terms:
- aircraft;
- heavier-than-air aircraft;
- State of Registry.

Source: ICAO Annex 7, Chapter 1 Definitions
Nationality marks, common marks and registration marks
Nationality marks, common marks and registration marks - assignment and location.
Source: ICAO Annex 7
State the location of nationality marks, common marks and registration marks.
Source: ICAO Annex 7, Chapter 4.3 Heavier-than-air aircraft; ICAO Annex 7, Chapter 9 Identification plate
Explain who is responsible for assigning nationality marks, common marks and registration marks.
Source: ICAO Annex 7, Chapter 3 Nationality, common and registration marks to be used
PERSONNEL LICENSING
ICAO Annex 1

Differences between ICAO Annex 1 and Regulation (EU) No 1178/2011 (hereinafter: Aircrew Regulation)
Describe the relationship and differences between ICAO Annex 1 and the Aircrew Regulation.
Aircrew Regulation - Annex I (Part-FCL).
Source: Aircrew Regulation
Definitions
Define the following: Category, class and type of aircraft, cross-country, dual instruction time, flight time, student pilot-in-command (SPIC), instrument time, instrument flight time, instrument ground time, night, private pilot, proficiency check, renewal, revalidation, skill test, solo flight time.
Source: Aircrew Regulation, point FCL.010 Definitions
Define the following: multi-crew cooperation (MCC), multi-pilot aircraft, rating.
Source: Aircrew Regulation, point FCL.010 Definitions; Note: "rating" is defined in point 1.1 Definitions of ICAO Annex 1
Content and structure
Explain the structure of Part-FCL.
Source: Aircrew Regulation, Article 1 Subject matter
Explain the requirements to act as a flight crew member of a civil aircraft registered in a Member State, and know the general principles of the licensing system (light aircraft pilot licence (LAPL), private pilot licence (PPL), commercial pilot licence (CPL), multi-crew pilot licence (MPL), airline transport pilot licence (ATPL)).
Source: Regulation (EU) 2018/1139, Article 21 and point 2 of Annex IV 'Essential requirements for aircrew' to this Regulation; Aircrew Regulation, point FCL.015 Application and issue, revalidation and renewal of licences, ratings and certificates
List the two factors that are relevant to the exercise of the privileges of a licence.
Source: Aircrew Regulation, point FCL.040 Exercise of the privileges of licences
State the circumstances in which a language proficiency endorsement is required.
Source: Aircrew Regulation, point FCL.055 Language proficiency
List the restrictions for licence holders with an age of 60 years or more.
Source: Aircrew Regulation, point FCL.065 Curtailment of privileges of licence holders aged 60 years or more in commercial air transport
Explain the term 'competent authority'.
Source: Aircrew Regulation, point FCL.001 Competent authority
Describe the obligation to carry and present documents (e.g. a flight crew licence) under Part-FCL.
Source: Aircrew Regulation, point FCL.045 Obligation to carry and present documents
Commercial pilot licence (CPL)
State the requirements for the issue of a CPL.
Source: Aircrew Regulation: point FCL.300 CPL - Minimum age; Appendix 3, D. CPL integrated course - Aeroplanes, Flying Training (8, a–f); Appendix 3, E. CPL modular course - Aeroplanes, Experience (12, a–d)
State the privileges of a CPL.
Source: Aircrew Regulation, point FCL.305 CPL - Privileges and conditions
Airline transport pilot licence (ATPL) and multi-crew pilot licence (MPL)
State the requirements for the issue of an ATPL.
Source: Aircrew Regulation, point FCL.500 ATPL - Minimum age; Aircrew Regulation, point FCL.510.A ATPL(A) - Prerequisites, experience and crediting ((a) and (b)); Aircrew Regulation, point FCL.510.H ATPL(H) - Prerequisites, experience and crediting
State the privileges of an ATPL.
Source: Aircrew Regulation, point FCL.505 ATPL - Privileges
State the requirements for the issue of an MPL.
Source: Aircrew Regulation, point FCL.400.A MPL - Minimum age; Aircrew Regulation, point FCL.410.A MPL - Training course and theoretical knowledge examinations and Appendix 5 (items 1 to 8)
State the privileges of an MPL.
Source: Aircrew Regulation, point FCL.405.A MPL - Privileges
Ratings
State the requirements for class ratings, their validity and privileges.
Source: Aircrew Regulation, point FCL.740 Validity and renewal of class and type ratings; Aircrew Regulation, point FCL.705 Privileges of the holder of a class or type rating; Aircrew Regulation, point FCL.720.A Experience requirements and prerequisites for the issue of class or type ratings - aeroplanes
State the requirements for type ratings, their validity and privileges.
Source: Aircrew Regulation, point FCL.705 Privileges of the holder of a class or type rating; Aircrew Regulation, point FCL.720.A Experience requirements and prerequisites for the issue of class or type ratings - aeroplanes; Aircrew Regulation, point FCL.740 Validity and renewal of class and type ratings

State the requirements for instrument ratings, their validity and privileges (instrument rating (IR), competency-based instrument rating (CBIR) and en-route instrument rating (EIR)).

Source: Aircrew Regulation, point FCL.610 IR - Prerequisites and crediting; Aircrew Regulation, point FCL.605 IR - Privileges; Aircrew Regulation, point FCL.625 IR - Validity, revalidation and renewal

State the requirements for other ratings, their validity and privileges according to Part-FCL.

Source: Aircrew Regulation, point FCL.800 Aerobatic rating; Aircrew Regulation, point FCL.805 Sailplane towing and banner towing ratings; Aircrew Regulation, point FCL.810 Night rating; Aircrew Regulation, point FCL.815 Mountain rating; Aircrew Regulation, point FCL.820 Flight test rating.

Aircrew Regulation - Annex IV (Part-MED)

Aircrew Regulation - Annex IV (Part-MED) - Details

Describe the relevant content of Part-MED - Medical requirements (administrative parts and requirements related to licensing only).

Source: Aircrew Regulation, point MED.A.001 Competent authority; Aircrew Regulation, point MED.A.005 Scope; Aircrew Regulation, point MED.A.045 Validity, revalidation and renewal of medical certificates

State the requirements for the issue of a medical certificate.

Source: Aircrew Regulation, point MED.A.040 Issue, revalidation and renewal of medical certificates

Name the class of medical certificate required when exercising the privileges of a CPL, MPL or ATPL.

Source: Aircrew Regulation, point MED.A.030 Medical certificates

State the actions to be taken in case of a decrease in medical fitness.

Source: Aircrew Regulation, point MED.A.020 Decrease in medical fitness

RULES OF THE AIR ACCORDING TO ICAO ANNEX 2 AND SERA

Overview of ICAO Annex 2 and SERA (Commission Implementing Regulation (EU) No 923/2012 and its references and subsequent amendments)

ICAO Annex 2 and SERA - Relationship and content

Explain the scope and purpose of ICAO Annex 2.

Source: ICAO Annex 2, Foreword, Applicability

Explain the scope and main content of SERA.

Source: SERA, Article 1 Subject matter and scope

Rules of the Air

Applicability of the Rules of the Air

Explain the principle of territorial application of the various Rules of the Air, e.g. ICAO, SERA, national rules.

Source: ICAO Annex 2, Chapter 2, 2.1 Territorial application of the rules of the air; SERA.1001 and SERA.2001

Explain the necessity to comply with the Rules of the Air.

Source: SERA.2005 Compliance with the rules of the air

State the responsibilities of the PIC.

Source: SERA.2010 Responsibilities.

Identify under what circumstances departure from the Rules of the Air may be allowed.

Source: SERA.2010 Responsibilities

Explain the duties of the PIC concerning pre-flight actions in case of an instrument flight rule (IFR) flight.

Source: SERA.2010 Responsibilities

State that the PIC of an aircraft has final authority as to the disposition of the aircraft while in command.

Source: SERA.2015 Authority of pilot-in-command of an aircraft

Explain when the use of psychoactive substances, taking into consideration their effects, by flight crew members is prohibited.

Source: SERA.2020 Problematic use of psychoactive substances

General rules

General rules - Collision avoidance - SERA

Describe the rules for the avoidance of collisions.

Source: SERA Chapter 2 Avoidance of collisions (except water operations)

Describe the lights, including their angles, to be displayed by aircraft.

Source: SERA.3215 Lights to be displayed by aircraft; ICAO Annex 2, Chapter 3, 3.2.3; ICAO Annex 6, Part I, Chapter 6, 6.10 and Appendix 1; and ICAO Annex 6, Part III, Chapter 4, 4.42.

Interpret marshalling signals.

Source: SERA Appendix 1, Chapter 4 Marshalling signals

State the basic requirements for minimum height (HGT) for the flight over congested areas of cities, towns or settlements, or over an open-air assembly of persons.

Source: SERA.3105 Minimum heights

Define when the cruising levels shall be expressed in terms of flight levels (FLs).

Source: SERA.3110 Cruising levels

Define under what circumstances cruising levels shall be expressed in terms of altitude (ALT).
Source: SERA.3110 Cruising levels
Explain the limitation for proximity to other aircraft and the right-of-way rules, including holding at runway (RWY) holding positions and lighted stop bars.
Source SERA.3205 Proximity; SERA.3210 Right-of-way
Describe the meaning of light signals displayed to aircraft and by aircraft.
Source: SERA.3215 Lights to be displayed by aircraft; SERA, Appendix 1, Chapter 3 Signals for aerodrome traffic
Describe the requirements when carrying out simulated instrument flights.
Source: SERA.3220 Simulated instrument flights
Explain the basic rules for an aircraft operating on and in the vicinity of an aerodrome (AD).
Source: SERA.3225 Operation on and in the vicinity of an aerodrome
Explain the requirements for the submission of an air traffic service (ATS) flight plan.
Source: SERA.4001 Submission of a flight plan
Explain the actions to be taken in case of flight plan change or delay.
Source: SERA.4015 Changes to a flight plan; SERA.8020 Adherence to flight plan
State the actions to be taken in case of inadvertent changes to track, true airspeed (TAS) and time estimate affecting the current flight plan.
Source: SERA.8020 Adherence to flight plan
Explain the procedures for closing a flight plan.
Source: SERA.4020 Closing a flight plan
State for which flights an air traffic control (ATC) clearance shall be obtained.
Source: SERA.8015 Air traffic control clearances
State how a pilot may request ATC clearance.
Source: SERA.8015 Air traffic control clearances
State the action to be taken if an ATC clearance is not satisfactory to a PIC.
Source: SERA.8015 Air traffic control clearances
Describe the required actions to be carried out if the continuation of a controlled visual flight rule (VFR) flight in visual meteorological conditions (VMC) is not practicable any more.
Source: SERA.8020 Adherence to flight plan
Describe the provisions for transmitting a position report to the appropriate ATS unit including time of transmission and normal content of the message.
Source: SERA.8025 Position reports
Describe the necessary action when an aircraft experiences a communication (COM) failure.
Source: SERA.8035 Communications
State what information an aircraft being subjected to unlawful interference shall give to the appropriate ATS unit.
Source: SERA.11001 Unlawful interference
Visual flight rules (VFR)
Visual flight rules (VFR) - SERA
Describe the VFR as contained in Commission Implementing Regulation (EU) No 923/2012.
Source: SERA.5001 VMC visibility and distance from cloud minima; SERA.5005 Visual flight rules; SERA.5010 Special VFR in control zones
Instrument flight rules (IFR)
Instrument flight rules (IFR) - SERA
Describe the IFR as contained in Commission Implementing Regulation (EU) No 923/2012.
Source: SERA.5015 Instrument flight rules (IFR) - Rules applicable to all IFR flights; SERA.5020 IFR - Rules applicable to IFR flights within controlled airspace; SERA.5025 IFR - Rules applicable to IFR flights outside controlled airspace
Interception of civil aircraft
Interception of civil aircraft - SERA
List the circumstances in which interception of a civil aircraft may occur.
Source: SERA.11015 Interception; ICAO Doc 9433, 1.2 Circumstances in which interception may occur
State what primary action should be carried out by an intercepted aircraft.
Source: SERA.11015 Interception
State which frequency should primarily be tried in order to contact an intercepting aircraft.
Source: SERA.11015 Interception
State on which mode and code a transponder on board the intercepted aircraft should be operated.
Source: SERA.11015 Interception
Recall the interception signals and phrases.
Source: SERA.11015 Interception, Tables S11-1, S11-2, S11-3
AIRCRAFT OPERATIONS

Definitions and abbreviations (PANS-OPS Flight Procedures, ICAO Doc 8168, Volume I)

Definitions and abbreviations - ICAO Doc 8168, Volume I

Recall all definitions included in ICAO Doc 8168, Volume I, Part I, Section 1, Chapter 1.

Source: ICAO Doc 8168, Volume I, Part I, Section 1, Chapter 1

Interpret all abbreviations and acronyms as shown in ICAO Doc 8168, Volume I, Part I, Section 1, Chapter 2.

Source: ICAO Doc 8168, Volume I, Part I, Section 1, Chapter 2

Departure procedures - (ICAO Doc 8168, Volume I)

General criteria (assuming all engines operating)

State the factors dictating the design of instrument departure procedures.

Source: ICAO Doc 8168, Volume I, Part II, Section 1, Chapter 1, 1.1 General

Explain in which situations the criteria for omnidirectional departures are applied.

Source: ICAO Doc 8168, Volume I, Part II, Section 2, Chapter 3, Omnidirectional departures, 3.1.1; 3.1.2; 3.1.3

Standard instrument departures (SIDs)

Explain the terms 'straight departure' and 'turning departure'.

Source: ICAO Doc 8168, Volume I, Part II, Section 2, Chapter 2, 2.1 General; 2.3 Straight Departures; 2.4 Turning (excluding maximum speeds)

Omnidirectional departures

Explain what is the meaning of an 'omnidirectional departure.

Source: ICAO Doc 8168, Volume I, Attachment B, paragraph 2.5

Approach procedures - ICAO Doc 8168, Volume I

General criteria

State the general criteria (except 'Speeds for procedure calculations') of the approach procedure design: instrument approach areas; accuracy of fixes; fixes formed by intersections; intersection fix-tolerance factors; other fix-tolerance factors; descent gradient.

Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 1

Name the five possible segments of an instrument approach procedure.

Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 1, 1.2.3 Segments of the approach procedure

State the reasons for establishing aircraft categories for the approach.

Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 1, 1.4 Categories of aircraft

State the maximum angle between the final approach track and the extended RWY centre line to still consider a non-precision approach as being a 'straight-in approach'.

Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 1, 1.2.4 Types of approach

State the minimum obstacle clearance (MOC) provided by the minimum sector altitudes (MSAs) established for an aerodrome.

Source: ICAO Doc 8168, Volume I, Part II, Section 4, Chapter 1, 1.3 Minimum sector altitudes (MSA)/terminal arrival altitudes (TAA)

State that a pilot shall apply wind corrections when carrying out an instrument approach procedure.

State the most significant factor influencing the conduct of instrument approach procedures.

Source: ICAO Doc 8168, Volume I, Part II, Section 2, Chapter 1

Explain why a pilot should not descend below obstacle clearance altitude/height (OCA/H), which are established for: precision approach procedures; non-precision approach procedures; visual (circling) procedures; APV approach procedures.

Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 1, 1.6 Obstacle clearance altitude/height (OCA/H)

Describe in general terms the relevant factors for the calculation of operational minima.

Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 1, 1.7 Factors affecting operational minima

State the following acronyms in plain language: DA, DH, OCA, OCH, MDA, MDH, MOC, DA/H, OCA/H, MDA/H.

Source: ICAO Doc 8168, Volume I, Part I, Section 1, Chapters 1 and 2

Explain the relationship between the terms: DA, DH, OCA, OCH, MDA, MDH, MOC, DA/H, OCA/H, and MDA/H.

Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 1 General requirements

Approach procedure design

Describe how the vertical cross section for each of the five approach segments is broken down into the various areas.

Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 1 General requirements

State within which area of the cross section the minimum obstacle clearance (MOC) is provided for the whole width of the area.

Source: ICAO Doc 8168, Volume I, Part II, Section 1, Chapter 1, 1.3 Areas, 1.3.1

Define the terms 'IAF', 'IF', 'FAF', 'FAP', 'MAPt' and 'TP'.

Source: ICAO Doc 8168, Volume I, Part I, Section 1 Definitions, abbreviations and acronyms and units of measurement

State the accuracy of facilities providing track (VHF omnidirectional radio range (VOR), instrument landing system (ILS), non-directional beacon (NDB)).
Source: ICAO Doc 8168, Volume I, Attachment A, Section 2, Table A-2-1. System use accuracy (2 SD) of facility providing track guidance and facility not providing track guidance
State the optimum descent gradient (preferred for a precision approach) in degrees and per cent.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 1, 1.10 Descent gradient.
Arrival and approach segments
Name the five standard segments of an instrument approach procedure, and state the beginning and end for each of them.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 1, 1.2 Instrument approach procedure
Describe where an arrival route normally ends.
Source: ICAO Doc 8168, Volume I, Part II, Section 4 Arrival procedures, Chapter 1 General requirements
State the main task of the initial approach segment.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 3 Initial approach segment
Describe the maximum angle of interception between the initial approach segment and the intermediate approach segment (provided at the intermediate fix) for a precision approach and a non-precision approach.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 3 Initial approach segment
Describe the main task of the intermediate approach segment.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 4 Intermediate approach segment
State the main task of the final approach segment.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 5 Final approach segment
Name the two possible aims of a final approach.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, 5, Chapter 1 General requirements and Chapter 5 Final approach
Explain the term 'final approach point' in case of an ILS approach.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 5 Final approach segment
State what happens if an ILS glide path (GP) becomes inoperative during the approach.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 5 Final approach segment
Missed approach
Name the three phases of a missed approach procedure and describe their geometric limits.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 7 Missed approach segment
State the main task of a missed approach procedure.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 7 Missed approach segment
Define the term 'missed approach point (MAPt)'.
Source: ICAO Doc 8168, Volume I, Part I, Section 1 Definitions, abbreviations and acronyms and units of measurement
Describe how an MAPt may be established in an approach procedure.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 7 Missed approach segment
State the pilot's action if, upon reaching the MAPt, the required visual reference is not established.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 7 Missed approach segment
Describe what a pilot is expected to do in the event a missed approach is initiated prior to arriving at the MAPt.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 7 Missed approach segment
State whether the pilot is obliged to cross the MAPt at the height (HGT)/altitude (ALT) required by the procedure or whether they are allowed to cross the MAPt at a HGT/ALT greater than that required by the procedure.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 7 Missed approach segment
Visual manoeuvring (circling) in the vicinity of the aerodrome (AD)
Describe what is meant by 'visual manoeuvring (circling)'.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 6 Visual manoeuvring (circling)
Describe how a prominent obstacle in the visual manoeuvring (circling) area outside the final approach and missed approach area has to be considered for the visual circling.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 6 Visual manoeuvring (circling)
State for which category of aircraft the obstacle clearance altitude/height (OCA/H) within an established visual manoeuvring (circling) area is determined.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 6 Visual manoeuvring (circling)
Describe how the minimum descent altitude/height (MDA/H) is specified for visual manoeuvring (circling) if the OCA/H is known.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 6 Visual manoeuvring (circling)
State the conditions to be fulfilled before descending below MDA/H in a visual manoeuvring (circling) approach.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 6 Visual manoeuvring (circling)

Explain why there can be no single procedure designed that will cater for conducting a circling approach in every situation.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 6 Visual manoeuvring (circling)
State how the pilot is expected to act after initial visual contact during a visual manoeuvring (circling).
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 6 Visual manoeuvring (circling)
Describe what the pilot is expected to do if visual reference is lost while circling to land from an instrument approach.
Source: ICAO Doc 8168, Volume I, Part II, Section 5, Chapter 6 Visual manoeuvring (circling)
Note: VOR and VOR/DME are covered under 062 02 03 00 and 062 02 04 00
Holding procedures - ICAO Doc 8168, Volume I
Entry and holding
Explain why deviations from the in-flight procedures of a holding established in accordance with ICAO Doc 8168 are dangerous.
Source: ICAO Doc 8168, Volume I, Part II, Section 6
State that if for any reason a pilot is unable to conform to the procedures for normal conditions laid down for any particular holding pattern, this pilot should advise ATC as early as possible.
Source: ICAO Doc 8168, Volume I, Part II, Section 6
Describe the shape and terminology associated with the holding pattern.
Source: ICAO Doc 8168, Volume I, Part II, Section 6
State the bank angle and rate of turn to be used whilst flying in a holding pattern.
Source: ICAO Doc 8168, Volume I, Part II, Section 6
Explain why a pilot in a holding pattern should attempt to maintain tracks and how this can be achieved.
Source: ICAO Doc 8168, Volume I, Part II, Section 6
Describe where outbound timing begins in a holding pattern.
Source: ICAO Doc 8168, Volume I, Part II, Section 6
State where the outbound leg in a holding terminates if the outbound leg is based on DME.
Source: ICAO Doc 8168, Volume I, Part II, Section 6
Describe the three heading entry sectors for entries into a holding pattern.
Source: ICAO Doc 8168, Volume I, Part II, Section 6
Describe the terms 'parallel entry', 'offset entry' and 'direct entry'.
Source: ICAO Doc 8168, Volume I, Part II, Section 6
Determine the correct entry procedure for a given holding pattern.
Source: ICAO Doc 8168, Volume I, Part II, Section 6
State the still-air time for flying the outbound entry heading with or without DME.
Source: ICAO Doc 8168, Volume I, Part II, Section 6
Describe what the pilot is expected to do when clearance is received specifying the time of departure from the holding point.
Source: ICAO Doc 8168, Volume I, Part II, Section 6
Obstacle clearance
Describe the layout of the basic holding area, entry area and buffer area of a holding pattern.
Source: ICAO Doc 8168, Volume I, Part II, Section 6
State which obstacle clearance is provided by a minimum permissible holding level referring to the holding area, the buffer area (general only) and over high terrain or in mountainous areas.
Source: ICAO Doc 8168, Volume I, Part II, Section 6
Altimeter-setting procedures - ICAO Doc 8168
Basic requirements and procedures
Describe the two main objectives of altimeter settings.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 1
Define the terms 'QNH' and 'QFE'.
Source: ICAO Doc 8168, Volume I, Part I, Section 2, Chapter 2; ICAO Doc 8168, Volume III, Section 2, Chapter 1
Describe the different terms for ALT or flight levels (FLs) respectively, which are the references during climb or descent to change the altimeter settings from QNH to 1013.2 hPa and vice versa.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 1
Define the term 'flight level (FL)'.
Source: ICAO Doc 8168, Volume I, Part I, Section 1 Definitions, abbreviations and acronyms and units of measurement
State where FL zero shall be located.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 2
State the interval by which consecutive FLs shall be separated.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 2

Describe how FLs are defined.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 2
Define the term 'transition altitude (TA)'.
Source: ICAO Doc 8168, Volume I, Part I, Section 1 Definitions, abbreviations and acronyms and units of measurement
State how TAs shall normally be specified.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 2
Explain how the HGT of the TA is calculated and expressed in practice.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 2
State where TAs shall be published.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 2
Define the term 'transition level (TRL)'.
Source: ICAO Doc 8168, Volume I, Part I, Section 1 Definitions, abbreviations and acronyms and units of measurement
State when the TRL is normally passed on to the aircraft.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 2
State how the vertical position of the aircraft shall be expressed at or below the TA and TRL.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 2
Define the term 'transition layer'.
Source: ICAO Doc 8168, Volume I, Part I, Section 1 Definitions, abbreviations and acronyms and units of measurement
Describe when the vertical position of an aircraft passing through the transition layer shall be expressed in terms of FLs and when in terms of ALT.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 2
State when the QNH altimeter setting shall be made available to departing aircraft.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 2
Explain when the vertical separation of an aircraft during en-route flight shall be assessed in terms of ALT and when in terms of FLs.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 3
Explain when, in air–ground communications during an en-route flight, the vertical position of an aircraft shall be expressed in terms of ALT and when in terms of FLs.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 3
Describe why QNH altimeter-setting reports should be provided from sufficient locations.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 2
State how a QNH altimeter setting shall be made available to aircraft approaching a controlled aerodrome (AD) for landing.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 2
State under which circumstances the vertical position of an aircraft above the TRL may be referenced in ALT.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 2
Procedures for operators and pilots
State on which setting at least one altimeter shall be set prior to take-off.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 3
State where during the climb the altimeter setting shall be changed from QNH to 1013.2 hPa.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 3
Describe when a pilot of an aircraft intending to land at an AD shall obtain the TRL.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 3
Describe when a pilot of an aircraft intending to land at an AD shall obtain the actual QNH altimeter setting.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 3
State where the altimeter settings shall be changed from 1013.2 hPa to QNH during descent for landing.
Source: ICAO Doc 8168, Volume III, Section 2, Chapter 3
Parallel or near-parallel instrument RWYs - ICAO Doc 8168, Volume I
Simultaneous operation on parallel or near-parallel instrument RWYs
Describe the difference between independent and dependent parallel approaches.
Source: ICAO Doc 8168, Volume III, Section 3, Chapter 1
Describe the following different operations: simultaneous instrument departures; segregated parallel approaches/departures; semi-mixed and mixed operations.
Source: ICAO Doc 8168, Volume III, Section 3, Chapter 1
Describe the terms 'normal operating zone (NOZ)' and 'no transgression zone (NTZ)'.
Source: ICAO Doc 8168, Volume III, Section 1, Chapter 1; ICAO Doc 4444, Chapter 6 (Note: For the dimensions of the NTZ)

State the aircraft avionics requirements for conducting parallel instrument approaches.

Source: ICAO Doc 8168, Volume III, Section 3, Chapter 1

State where guidance material may be located for simultaneous operations on parallel or near-parallel instrument runways.

Source: ICAO Doc 8168, Volume III, Section 3, Chapter 1

State the radar requirements for simultaneous, independent, and parallel instrument approaches, and how weather conditions effect these.

Source: ICAO Doc 8168, Volume III, Section 3, Chapter 1; ICAO Doc 4444, Chapter 6

State the maximum angle of interception for an ILS localiser course (CRS) or microwave landing system (MLS) final approach track in case of simultaneous, independent, and parallel instrument approaches.

Source: ICAO Doc 8168, Volume III, Section 3, Chapter 1

Describe the special conditions for tracks on missed approach procedures and departures in case of simultaneous or parallel operations.

Source: ICAO Doc 8168, Volume III, Section 3, Chapter 1

Secondary surveillance radar (transponder) operating procedures - ICAO Doc 8168

Operation of transponders

State when and where the pilot shall operate the transponder.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 1

State the modes and codes that the pilot shall operate in the absence of any ATC directions or regional air navigation agreements.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 1

State when the pilot shall operate Mode C.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 1

State when the pilot shall 'SQUAWK IDENT'.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 1

State the transponder code to indicate: a state of emergency; a COM failure; unlawful interference.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 1

Describe the consequences of a transponder failure in flight.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 1

State the primary action of the pilot in the case of an unserviceable transponder before departure when no repair or replacement at the given AD is possible.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 1

State when the pilot shall operate Mode S.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 1

Operation of airborne collision avoidance system (ACAS) equipment

Describe the main reason for using ACAS.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 3, 3.1 ACAS overview

State whether the 'use of ACAS indications' described in ICAO Doc 8168 is absolutely mandatory.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 3, 3.2 Use of ACAS indications

Explain the pilots' reaction required to allow ACAS to fulfil its role of assisting pilots in the avoidance of potential collisions.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 3, 3.2 Use of ACAS indications

Explain why pilots shall not manoeuvre their aircraft in response to traffic advisories (TAs) only.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 3, 3.2 Use of ACAS indications

Explain the significance of TAs in view of possible resolution advisories (RAs).

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 3, 3.2 Use of ACAS indications

State why a pilot should follow RAs immediately.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 3, 3.2 Use of ACAS indications

List the reasons which may force a pilot to disregard an RA.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 3, 3.2 Use of ACAS indications

Explain the importance of instructing ATC immediately that an RA has been followed.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 3, 3.2 Use of ACAS indications

Explain the duties of a pilot with regard to ATC when an RA situation is resolved.

Source: ICAO Doc 8168, Volume III, Section 4, Chapter 3, 3.2 Use of ACAS indications

REGULATION (EU) No 965/2012 ON AIR OPERATIONS

Regulation structure

Describe the subject matter and scope of that Regulation.

Source: Regulation (EU) No 965/2012, Article 1 Subject matter and scope

State that Regulation (EU) No 965/2012 covers all types of commercial and non-commercial operations.

Definitions (Annex I)

Recall the definitions in the Regulation not already given in ICAO PAN-OPS.

Source: Regulation (EU) No 965/2012, Article 2 Definitions

Part-SPA (Annex V), Part-NCC (Annex VI) and Part-NCO (Annex VII)

Describe the scope of these Parts.

Explain the main content of these Parts, except the operational procedures.

AIR TRAFFIC SERVICES (ATS) AND AIR TRAFFIC MANAGEMENT (ATM)

ICAO Annex 11 - Air Traffic Services

Definitions

Recall the definitions given in ICAO Annex 11.

Source: ICAO Annex 11, Chapter 1 Definitions

General

State the objectives of ATS.

Source: ICAO Annex 11, Chapter 2, 2.2 Objectives of ATS

Describe the three basic types of ATS.

Source: ICAO Annex 11, Chapter 2, 2.3 Divisions of the air traffic services

Describe the three basic types of ATC services.

Source: ICAO Annex 11, Chapter 2, 2.3 Divisions of the air traffic services

State on which frequencies a pilot can expect ATC to contact them in case of an emergency.

Source: ICAO Annex 11, Chapter 2, 2.24 Service to aircraft in the event of an emergency, 2.25 In-flight contingencies, Chapter 5, 5.3 Use of communication facilities, and Chapter 6, 6.1.1.1 (referring to Annex 10, Volumes II and V), Chapter 4, 4.1.3.1

Describe the procedure for the transfer of an aircraft from one ATC unit to another.

Source: ICAO Annex 11, Chapter 3, 3.6.1 Transfer of responsibility for control

Airspace

Describe the purpose for establishing flight information regions (FIRs) including upper flight information regions (UIRs).

Source: ICAO Annex 11, Chapter 2: 2.10; 2.11.

Describe the various rules and services that apply to the various classes of airspace.

Source: ICAO Annex 11, Chapter 2, 2.6 Classification of airspaces and Annex 11, Appendix 4

Explain which airspace shall be included in an FIR or UIR.

State the designation for those portions of the airspace where flight information service (FIS) and alerting service shall be provided.

Source: ICAO Annex 11, Chapter 2, 2.5 Designation of the portions of the airspace and controlled aerodromeswhere air traffic services will be provided

State the designations for those portions of the airspace where ATC services shall be provided.

Source: ICAO Annex 11, Chapter 2, 2.5 Designation of the portions of the airspace and controlled aerodromeswhere air traffic services will be provided

Identify whether or not control areas (CTAs) and control zones (CTRs) designated within an FIR shall form part of that FIR.

Source: ICAO Annex 11, Chapter 2, 2.5 Designation of the portions of the airspace and controlled aerodromeswhere air traffic services will be provided

State the lower limit of a CTA as far as ICAO Standards are concerned.

Source: ICAO Annex 11, Chapter 2, 2.11.3 Control areas

State whether or not the lower limit of a CTA has to be established uniformly.

Source: ICAO Annex 11, Chapter 2, 2.11.3 Control areas

Explain why a UIR or upper CTA should be delineated to include the upper airspace within the lateral limits of a number of lower FIRs or CTAs.

Source: ICAO Annex 11, Chapter 2, 2.11 Specifications for flight information regions, control areas and control zones

Describe in general the lateral limits of CTRs.

Source: ICAO Annex 11, Chapter 2, 2.11.5 Control zones

State the minimum extension (in NM) of the lateral limits of a CTR.

Source: ICAO Annex 11, Chapter 2, 2.11.5 Control zones

State the upper limits of a CTR located within the lateral limits of a CTA.

Source: ICAO Annex 11, Chapter 2, 2.11.5 Control zones

Air traffic control (ATC) services

Name all classes of airspace in which ATC services shall be provided.

Source: ICAO Annex 11, Chapter 3, 3.1 Application

Name the ATS units providing ATC services (area control service, approach control service, aerodrome control service).
Source: ICAO Annex 11, Chapter 3, 3.2 Provision of air traffic control service
Describe which unit(s) may be assigned with the task to provide specified services on the apron.
Source: ICAO Annex 11, Chapter 3, 3.2 Provision of air traffic control service
State the purpose of clearances issued by an ATC unit.
Source: ICAO Annex 11, Chapter 3, 3.3 Operation of air traffic control service
List the various (five possible) parts of an ATC clearance.
Source: ICAO Annex 11, Chapter 3, 3.7.1 Contents of clearances
Explain why the movement of persons, vehicles and towed aircraft on the manoeuvring area of an AD shall be controlled by the aerodrome control tower (TWR) (as necessary).
Source: ICAO Annex 11, Chapter 3, 3.8 Control of persons and vehicles at aerodromes, 3.8.1
Flight information service (FIS)
State for which aircraft FIS shall be provided.
Source: ICAO Annex 11, Chapter 4, 4.1 Application
State whether or not FIS shall include the provision of pertinent significant meteorological information (SIGMET) and air meteorological information report (AIRMET) information.
Source: ICAO Annex 11, Chapter 4, 4.2 Scope of flight information service
State which information FIS shall include in addition to SIGMET and AIRMET information.
Source: ICAO Annex 11, Chapter 4, 4.2 Scope of flight information service
Indicate which other information the FIS shall include in addition to the special information given in Annex 11.
Source: ICAO Annex 11, Chapter 4, 4.2 Scope of flight information service, 4.2.2 Note 2 and Attachment B
State the meaning of the acronym 'ATIS' in plain language.
Source: ICAO Annex 11, Chapter 4, 4.3.4 Voice-automatic terminal information service (Voice-ATIS) broadcasts
List the basic information concerning automatic terminal information service (ATIS) broadcasts (e.g. frequencies used, number of ADs included, updating, identification, acknowledgment of receipt, language and channels, ALT-setting).
Source: ICAO Annex 11, Chapter 4, 4.3.4 Voice-automatic terminal information service (Voice-ATIS) broadcasts
State the content of an ATIS message.
Source: ICAO Annex 11, Chapter 4, 4.3.7 ATIS for arriving and departing aircraft
State the reasons and circumstances when an ATIS message shall be updated.
Source: ICAO Annex 11, Chapter 4, 4.3.6 Automatic terminal information service (voice and/or data link)
Alerting service
State who provides the alerting service.
Source: ICAO Annex 11, Chapter 2, 2.10 Establishment and designation of the units providing air traffic services
State who is responsible for initiating the appropriate emergency phase.
Source: ICAO Annex 11, Chapter 5 Alerting service
State the aircraft to which alerting service shall be provided.
Source: ICAO Annex 11, Chapter 5 Alerting service
State which unit shall be notified by the responsible ATS unit immediately when an aircraft is considered to be in a state of emergency.
Source: ICAO Annex 11, Chapter 5 Alerting service
Name the three stages of emergency and describe the basic conditions for each kind of emergency.
Source: ICAO Annex 11, Chapter 5 Alerting service
State the meaning of the expressions 'INCERFA', 'ALERFA' and 'DETRESFA'.
Source: ICAO Annex 11, Chapter 5 Alerting service
State the information to be provided to those aircraft that operate in the vicinity of an aircraft that is either in a state of emergency or unlawful interference.
Source: ICAO Annex 11, Chapter 5 Alerting service
Principles governing required navigation performance (RNP) and air traffic service (ATS) route designators
State the meaning of the acronym 'RNP'.
Source: ICAO Annex 11, Chapter 1 Definitions
State the factors that RNP is based on.
Source: ICAO Annex 11, Chapter 1 Definitions (Navigation specification)
Describe the reason for establishing a system of route designators and navigation specifications.
Source: ICAO Annex 11, Appendix 1, 1. Designators for ATS routes and navigation specifications
State whether or not a prescribed RNP type is considered an integral part of the ATS route designator.
Source: ICAO Annex 11, Appendix 1, 1. Designators for ATS routes and navigation specifications

Explain the composition of an ATS route designator.
Source: ICAO Annex 11, Appendix 1, 2. Composition of designator (not to the extent of memorising the codes in 2.2.1)
ICAO Doc 4444 - Air Traffic Management
Foreword (Scope and purpose)
State which ATS units provide clearances that do, and do not, include the prevention of collision with terrain.
Source: ICAO Doc 4444, Foreword, 2 Scope and purpose, 2.1
Definitions
Recall all definitions given in ICAO Doc 4444 except the following accepting unit/controller, AD taxi circuit, aeronautical fixed service (AFS), aeronautical fixed station, air-taxiing, allocation, approach funnel, assignment, data convention, data processing, discrete code, D-value, flight status, ground effect, receiving unit/controller, sending unit/controller, transfer of control point, transferring unit/controller, unmanned free balloon.
Source: ICAO Doc 4444, Chapter 1 Definitions
ATS system capacity and air traffic flow management (ATFM)
Explain when and where ATFM services shall be implemented.
Source: ICAO Doc 4444, Chapter 3, 3.2 Air traffic flow management, 3.2.1 General
General provisions for air traffic services (ATS)
Describe who is responsible for the provision of flight information and alerting services within an FIR, within controlled airspace and at controlled ADs.
Source: ICAO Doc 4444, Chapter 4, 4.2 Responsibility for the provision of flight information service and alerting service
ATC clearances
State which information the issue of an ATC clearance is based on.
Source: ICAO Doc 4444, Chapter 4, 4.5 Air traffic control clearances, 4.5.1 Scope and purpose
Describe what a PIC should do if an ATC clearance is not suitable.
Source: ICAO Doc 4444, Chapter 4, 4.5 Air traffic control clearances, 4.5.1 Scope and purpose
State who bears the responsibility for adhering to the applicable rules and regulations whilst flying under the control of an ATC unit.
Source: ICAO Doc 4444, Chapter 4, 4.5 Air traffic control clearances, 4.5.1 Scope and purpose
State the two primary purposes of clearances issued by ATC units.
Source: ICAO Doc 4444, Chapter 4, 4.5 Air traffic control clearances, 4.5.1 Scope and purpose
State why clearances must be issued 'early enough' to aircraft.
Source: ICAO Doc 4444, Chapter 4, 4.5 Air traffic control clearances, 4.5.1 Scope and purpose
Explain what is meant by the expression 'clearance limit'.
Source: ICAO Doc 4444, Chapter 4, 4.5.7 Description of air traffic control clearances, 4.5.7.1 Clearance limit
Explain the meaning of the phrases 'cleared via flight planned route', 'cleared via (designation) departure' and 'cleared via (designation) arrival' in an ATC clearance.
Source: ICAO Doc 4444, Chapter 4, 4.5.7 Description of air traffic control clearances, 4.5.7.2 Route of flight
List which items of an ATC clearance shall always be read back by the flight crew.
Source: ICAO Doc 4444, Chapter 4, 4.5.7.5 Readback of clearances
Horizontal speed control instructions
Explain the reason for speed control by ATC.
Source: ICAO Doc 4444, Chapter 4, 4.6 Horizontal speed control instructions, 4.6.1 General
Define the maximum speed changes that ATC may impose.
Source: ICAO Doc 4444, Chapter 4, 4.6.3 Descending and arriving aircraft
State within what distance from the THR the PIC should not expect any kind of speed control.
Source: ICAO Doc 4444, Chapter 4, 4.6.3 Descending and arriving aircraft
Change from IFR to VFR flight
Explain how the change from IFR to VFR can be initiated by the PIC.
Source: ICAO Doc 4444, Chapter 4, 4.8 Change from IFR to VFR flight
Describe the expected reaction of the appropriate ATC unit upon a request to change from IFR to VFR.
Source: ICAO Doc 4444, Chapter 4, 4.8 Change from IFR to VFR flight
Wake turbulence
State the wake-turbulence categories of aircraft.
Source: ICAO Doc 4444, Chapter 4, 4.9.1 Wake turbulence categories of aircraft
State the wake-turbulence separation minima.
Source: ICAO Doc 4444, Chapter 5, 5.8 Time-based wake turbulence longitudinal separation minima; ICAO Doc 4444, Chapter 8, 8.7.3.4 (table of distance-based wake turbulence separation minima) and 8.7.3.4.1 (appropriate conditions for application)

Describe how a ‘heavy’ aircraft shall indicate this in the initial radiotelephony contact with ATS.
Source: ICAO Doc 4444, Chapter 4, 4.9.2 Indication of heavy wake turbulence category
Altimeter-setting procedures
Define the following terms: TRL; transition layer; and TA.
Source: ICAO Doc 4444, Chapter 1 Definitions
Describe how the vertical position of an aircraft in the vicinity of an AD shall be expressed at or below the TA, at or above the TRL, and while climbing or descending through the transition layer.
Source: ICAO Doc 4444, Chapter 4, 4.10.1 Expression of vertical position of aircraft
Describe when the HGT of an aircraft using QFE during an NDB approach is referred to the landing THR instead of the AD elevation.
Source: ICAO Doc 4444, Chapter 4, 4.10.1 Expression of vertical position of aircraft
State in which margin altimeter settings provided to aircraft shall be rounded up or down.
Source: ICAO Doc 4444, Chapter 4, 4.10.4 Provision of altimeter setting information
Describe the expression ‘lowest usable FL’.
Source: ICAO Doc 4444, Chapter 4, 4.10.4 Provision of altimeter setting information
Determine how the vertical position of an aircraft on an en-route flight is expressed at or above the lowest usable FL and below the lowest usable FL.
Source: ICAO Doc 4444, Chapter 4, 4.10.1 Expression of vertical position of aircraft
State who establishes the TRL to be used in the vicinity of an AD.
Source: ICAO Doc 4444, Chapter 4, 4.10.2 Determination of the transition level
Decide how and when a flight crew member shall be informed about the TRL.
Source: ICAO Doc 4444, Chapter 4, 4.10.4 Provision of altimeter setting information
State whether or not the pilot can request TRL to be included in the approach clearance.
Source: ICAO Doc 4444, Chapter 4, 4.10.4 Provision of altimeter setting information
Position reporting
Describe when position reports shall be made by an aircraft flying on routes defined by designated significant points.
Source: ICAO Doc 4444, Chapter 4, 4.11.1 Transmission of position reports, 4.11.1.1
List the six items that are normally included in a voice position report.
Source: ICAO Doc 4444, Chapter 4, 4.11.2 Contents of voice position reports
State the requirements for using a simplified position report with FL, next position (and time-over) and ensuing significant points omitted.
Source: ICAO Doc 4444, Chapter 4, 4.11.2 Contents of voice position reports
State the item of a position report which must be forwarded on to ATC with the initial call after changing to a new frequency.
Source: ICAO Doc 4444, Chapter 4, 4.11.2 Contents of voice position reports
Indicate the item of a position report which may be omitted if secondary surveillance radar (SSR) Mode C is used.
Source: ICAO Doc 4444, Chapter 4, 4.11.2 Contents of voice position reports
Explain in which circumstances the airspeed should be included in a position report.
Source: ICAO Doc 4444, Chapter 4, 4.11.2 Contents of voice position reports
Explain the meaning of the acronym ‘ADS’.
Describe which expression shall precede the level figures in a position report if the level is reported in relation to 1013.2 hPa (standard pressure).
Source: ICAO Doc 4444, Chapter 4, 4.5.7.5 Readback of clearances; ICAO Doc 4444, Chapter 4, 4.11.2 Contents of voice position reports
Reporting of operational and meteorological information
List the occasions when special air-reports shall be made.
Source: ICAO Doc 4444, Chapter 4, 4.12.3 Contents of special air-reports 4.12.3.1 (a to k inclusive)
Separation methods and minima
Explain the general provisions for the separation of controlled air traffic.
Source: ICAO Doc 4444, Chapter 5, 5.2.1 General and 5.2.2 Degraded aircraft performance
Name the different kinds of separation used in aviation.
Source: ICAO Doc 4444, Chapter 5; ICAO Annex 11, Chapter 3, 3.5.2
State the difference between the type of separation provided within the various classes of airspace and the various types of flight.
Source: ICAO Doc 4444, Chapter 5, 5.2 Provisions for the separation of controlled traffic
State who is responsible for the avoidance of collision with other aircraft when operating in VMC.
Source: ICAO Doc 4444, Chapter 5, 5.9 Clearances to fly maintaining own separation while in VMC
Describe how vertical separation is obtained.
Source: ICAO Doc 4444, Chapter 5, 5.3.1 Vertical separation application

State the required vertical separation minimum.
Source: ICAO Doc 4444, Chapter 5, 5.3.2 Vertical separation minimum
Describe how the cruising levels of aircraft flying to the same destination and in the expected approach sequence are correlated with each other.
Source: ICAO Doc 4444, Chapter 5, 5.3.3 Assignment of cruising levels for controlled flights
Name the conditions that must be adhered to when two aircraft are cleared to maintain a specified vertical separation between them during climb or descent.
Source: ICAO Doc 4444, Chapter 5, 5.3.4 Vertical separation during climb or descent
State the two main methods for horizontal separation.
Source: ICAO Doc 4444, Chapter 5
Describe how lateral separation of aircraft at the same level may be obtained.
Source: ICAO Doc 4444, Chapter 5, 5.4.1 Lateral separation, 5.4.1.1.2
Explain the term 'geographical separation'.
Source: ICAO Doc 4444, Chapter 5, 5.4.1 Lateral separation
Describe track separation between aircraft using the same navigation aid or method.
Source: ICAO Doc 4444, Chapter 5, 5.4.1.2 Lateral separation criteria and minima, 5.4.1.2.1.2
Describe the three basic means for the establishment of longitudinal separation.
Source: ICAO Doc 4444, Chapter 5, 5.4.2
State the minimum standard horizontal radar separation in NM.
Source: ICAO Doc 4444, Chapter 5
Describe the method of the Mach number technique.
Source: ICAO Doc 4444, Chapter 5, 5.4.2.4 Longitudinal separation minima with mach number technique based on time

Separation in the vicinity of aerodromes (ADs)

Describe the expression 'essential local traffic'.
Source: ICAO Doc 4444, Chapter 6, 6.2 Essential local traffic
State which possible decision the PIC may choose to take if they are asked to accept take-off in a direction which is not 'into the wind'.
Source: ICAO Doc 4444, Chapter 6, 6.3.3 Departure sequence
State the condition to enable ATC to initiate a visual approach for an IFR flight.
Source: ICAO Doc 4444, Chapter 6, 6.5.3 Visual approach, 6.5.3.1
State whether or not separation shall be provided by ATC between an aircraft executing a visual approach and other arriving or departing aircraft.
Source: ICAO Doc 4444, Chapter 6, 6.5.3 Visual approach, 6.5.3.4
State in which case, when the flight crew are not familiar with the instrument approach procedure being carried out, only the final approach track has to be given to them by ATC.
Source: ICAO Doc 4444, Chapter 6, 6.5.4 Instrument approach
Describe which FL should be assigned to an aircraft first arriving over a holding fix for landing.
Source: ICAO Doc 4444, Chapter 6, 6.5.5 Holding
State which kinds of priority can be applied to aircraft for a landing.
Source: ICAO Doc 4444, Chapter 6, 6.5.6 Approach sequence, 6.5.6.1 General
Describe the situation when a pilot of an aircraft in an approach sequence indicates their intention to hold for weather improvements.
Source: ICAO Doc 4444, Chapter 6, 6.5.6 Approach sequence, 6.5.6.1 General
Explain the term 'expected approach time' and the procedures for its use.
Source: ICAO Doc 4444, Chapter 6, 6.5.7 Expected approach time
State the reasons which could probably lead to the decision to use another take-off or landing direction than the one into the wind.
Source: ICAO Doc 4444, Chapter 7, 7.2 Selection of runway-in-use
State the possible consequences for a PIC if the 'RWY-in-use' is not considered suitable for the operation involved.
Source: ICAO Doc 4444, Chapter 7

Miscellaneous separation procedures

State the minimum separation between departing and arriving aircraft.
Source: ICAO Doc 4444, Chapter 5, 5.7 Separation of departing aircraft from arriving aircraft
State the non-radar wake-turbulence longitudinal separation minima.
Source: ICAO Doc 4444, Chapter 5 and 6
Describe the consequences of a clearance to 'maintain own separation' while in VMC.
Source: ICAO Doc 4444, Chapter 5, 5.8 Time-based wake turbulence longitudinal separation minima, 5.8.1; ICAO Doc 4444, Chapter 6, 6.5.3 Visual approach

Give a brief description of 'essential traffic' and 'essential traffic information'.
Source: ICAO Doc 4444, Chapter 5, 5.10 Essential traffic information
Describe the circumstances under which a reduction in separation minima may be allowed.
Source: ICAO Doc 4444, Chapter 6, 6.1 Reduction in separation minima in the vicinity of aerodromes

Arriving and departing aircraft

List the elements of information which shall be transmitted to an aircraft as early as practicable if an approach for landing is intended.
Source: ICAO Doc 4444, Chapter 6, 6.6 Information for arriving aircraft
List the elements of information to be transmitted to an aircraft at the commencement of final approach.
Source: ICAO Doc 4444, Chapter 6, 6.6 Information for arriving aircraft
List the elements of information to be transmitted to an aircraft during final approach.
Source: ICAO Doc 4444, Chapter 6, 6.6 Information for arriving aircraft
State the prerequisites for operating on parallel or near-parallel RWYs including the different combinations of parallel arrivals or departures.
Source: ICAO Doc 4444, Chapter 6, 6.7 Operations on parallel or near-parallel runways
State the sequence of priority between aircraft landing (or in the final stage of an approach to land) and aircraft intending to depart.
Source: ICAO Doc 4444, Chapter 7, 7.8 Order of priority for arriving and departing aircraft
State the significant changes in the meteorological conditions in the take-off or climb-out area that shall be transmitted without delay to a departing aircraft.
Source: ICAO Doc 4444, Chapter 6, 6.4.1 Meteorological conditions
State the significant changes that shall be transmitted as early as practicably possible to an arriving aircraft, particularly changes in the meteorological conditions.
Source: ICAO Doc 4444, Chapter 6, 6.6 Information for arriving aircraft

Procedures for aerodrome (AD) control service

Name the operational failure or irregularity of AD equipment which shall be reported by the TWR immediately.
Source: ICAO Doc 4444, Chapter 7, 7.1.3 Failure or irregularity of aids and equipment
Explain that, after a given period of time, the TWR shall report to the area control centre (ACC) or flight information centre (FIC) if an aircraft does not land as expected.
Source: ICAO Doc 4444, Chapter 7, 7.1.2 Alerting service provided by aerodrome control towers
Describe the procedures to be observed by the TWR whenever VFR operations are suspended.
Source: ICAO Doc 4444, Chapter 7, 7.13 Suspension of visual flight rules operations
Explain the term 'RWY-in-use' and its selection.
Source: ICAO Doc 4444, Chapter 7, 7.2 Selection of runway-in-use
List the information the TWR should give to an aircraft prior to: taxiing for take-off; take-off; entering the traffic circuit.
Source: ICAO Doc 4444, Chapter 7, 7.4.1.2 Aerodrome and meteorological information
Explain that a report of surface wind direction given to a pilot by the TWR is magnetic.
Source: ICAO Doc 4444, Chapter 11, 11.4.3.2 Messages containing meteorological information
Explain the exact meaning of the expression 'RWY vacated'.
Source: ICAO Doc 4444, Chapter 7, 7.10.3.4

Radar services

State the basic identification procedures used with radar.
Source: ICAO Doc 4444, Chapter 8, 8.6.2.3 SSR and/or MLAT identification procedures and Chapter 8, 8.6.2.4 PSR identification procedures
Define the term 'PSR'.
Source: ICAO Doc 4444, Chapter 1 Definitions
Describe the circumstances under which an aircraft provided with radar service should be informed of its position.
Source: ICAO Doc 4444, Chapter 8, 8.6.4 Position information
List the possible forms of position information passed on to the aircraft by radar services.
Source: ICAO Doc 4444, Chapter 8, 8.6.4 Position information
Describe the term 'radar vectoring'.
Source: ICAO Doc 4444, Chapter 8, 8.6.5 Vectoring
State the aims of radar vectoring as shown in ICAO Doc 4444.
Source: ICAO Doc 4444, Chapter 8, 8.6.5 Vectoring
Describe how radar vectoring shall be achieved.
Source: ICAO Doc 4444, Chapter 8, 8.6.5 Vectoring
Describe the information which shall be given to an aircraft when radar vectoring is terminated and the pilot is instructed to resume own navigation.
Source: ICAO Doc 4444, Chapter 8, 8.6.5 Vectoring

Explain the procedures for the conduct of surveillance radar approaches (SRAs).
Source: ICAO Doc 4444, Chapter 8, 8.9.7.1 Surveillance radar approach
Describe what kind of action (concerning the transponder) the pilot is expected to perform in case of emergency if they have previously been directed by ATC to operate the transponder on a specific code.
Source: ICAO Doc 4444, Chapter 8, 8.8.1 Emergencies
Air traffic advisory service
Describe the objective and basic principles of the air traffic advisory service.
Source: ICAO Doc 4444, Chapter 9, 9.1.4.1 Objective and basic principles
State to which aircraft air traffic advisory service may be provided.
Source: ICAO Doc 4444, Chapter 9, 9.1.4.1 Objective and basic principles
Explain the difference between advisory information and clearances, stating which ATS units are responsible for their issue.
Source: ICAO Doc 4444, Chapter 9, 9.1.4.1.3
Procedures related to emergencies, communication (COM) failure and contingencies
State the mode and code of SSR equipment a pilot might operate in a (general) state of emergency or (specifically) in case the aircraft is subject to unlawful interference.
Source: ICAO Doc 4444, Chapter 15, 15.1 Emergency procedures
State the special rights an aircraft in a state of emergency can expect from ATC.
Source: ICAO Doc 4444, Chapter 15, 15.1.1 General; 15.1.2 Priority; 15.1.3 Unlawful interference and aircraft bomb threat
Describe the expected action of aircraft after receiving a broadcast from ATS concerning the emergency descent of an aircraft.
Source: ICAO Doc 4444, Chapter 15, 15.1.4 Emergency descent
State how it can be ascertained, in case of a failure of two-way COM, whether the aircraft is able to receive transmissions from the ATS unit.
Source: ICAO Doc 4444, Chapter 15, 15.3 Air-ground communications failure
State on which frequencies appropriate information, for an aircraft encountering two-way COM failure, shall be sent by ATS.
Source: ICAO Doc 4444, Chapter 15, 15.3.5
State what is meant by the expressions ‘strayed aircraft’ and ‘unidentified aircraft’.
Source: ICAO Doc 4444, Chapter 15, 15.5.1 Strayed or unidentified aircraft
Explain the reasons for fuel-dumping and state the minimum level.
Source: ICAO Doc 4444, Chapter 15, 15.5.3 Fuel dumping
Explain the possible request of ATC to an aircraft to change its radio-telephone (RTF) call sign.
Miscellaneous procedures
Explain the meaning of ‘AIRPROX’.
Source: ICAO Doc 4444, Chapter 1 Definitions; ICAO Doc 4444, Chapter 16, 16.3 Air traffic incident report
Describe the task of an air traffic incident report.
Source: ICAO Doc 4444, Chapter 16, 16.3 Air traffic incident report
AERONAUTICAL INFORMATION SERVICE (AIS)
Introduction
Introduction to ICAO Annex 15 - Aeronautical Information Service (AIS)
State, in general terms, the objective of an AIS.
Source: ICAO Annex 15, Chapter 1, Note 1
Definitions of ICAO Annex 15
Definitions of ICAO Annex 15
Recall the following definitions aeronautical information circular (AIC), aeronautical information publication (AIP), AIP amendment, AIP supplement, aeronautical information regulation and control (AIRAC), danger area, aeronautical information management, international airport, international NOTAM office (NOF), manoeuvring area, movement area, NOTAM, pre-flight information bulletin (PIB), prohibited area, restricted area, SNOWTAM, ASHTAM.
Source: ICAO Annex 15, Chapter 1, 1.1 Definitions
General
General - AIS responsibilities and functions
State during which period of time an AIS shall be available with reference to an aircraft flying in the area of responsibility of an AIS, provided a 24-hour service is not available.
Source: ICAO Annex 15, Chapter 2, 2.2 AIS responsibilities and functions
List, in general, the kind of aeronautical information/data which an AIS service shall make available in a suitable form to flight crew.
Source: ICAO Annex 15, Chapter 2, 2.2 AIS responsibilities and functions

Summarise the duties of an AIS concerning aeronautical information data for the territory of a particular State.
Source: ICAO Annex 15, Chapter 2, 2.2 AIS responsibilities and functions; ICAO Annex 15, Chapter 2, 2.3 Exchange of aeronautical data and aeronautical information

Aeronautical information products and services

Aeronautical information publication (AIP)

State the primary purpose of the AIP.
Source: ICAO Annex 15, Chapter 5, 5.2.2, Notes 1 and 2

Name the different parts of the AIP.
Source: ICAO Annex 15, Chapter 5, 5.2.1, Note 1; PANS-AIM (ICAO Doc 10066), Chapter 5, 5.2.1.2.5

State the main parts of the AIP where the following information can be found: differences from the ICAO Standards, Recommended Practices and Procedures; location indicators, AIS, minimum flight ALT, meteorological information for aircraft in flight (VOLMET) service, SIGMET service; general rules and procedures (especially general rules, VFR, IFR, ALT-setting procedure, interception of civil aircraft, unlawful interference, air traffic incidents); ATS airspace (especially FIR, UIR, TMA); ATS routes (especially lower ATS routes, upper ATS routes, area navigation routes); AD data including aprons, taxiways (TWYs) and check locations/positions data; navigation warnings (especially prohibited, restricted and danger areas); aircraft instruments, equipment and flight documents; AD surface movement guidance and control system and markings; RWY physical characteristics, declared distances, approach (APP) and RWY lighting; AD radio navigation and landing aids; charts related to an AD; entry, transit and departure of aircraft, passengers, crew and cargo, and the significance of this information to flight crew.
Source: ICAO Annex 15, Chapter 5, 5.2.1, Note 1; PANS-AIM (ICAO Doc 10066), Appendix 2

State how permanent changes to the AIP shall be published.
Source: ICAO Annex 15, Chapter 5, 5.4 Distribution services and Chapter 6, 6.3.1 AIP updates, 6.3.1.2; PANS-AIM (ICAO Doc 10066), Chapter 5, 5.2.1 Aeronautical Information Publication (AIP), 5.2.1.3, 5.4 Distribution services, Chapter 6, 6.1.2 Specifications for AIP amendments

Explain what kind of information shall be published in the form of AIP Supplements.
Source: ICAO Annex 15, Chapter 6, 6.3.1 AIP updates, 6.3.1.3; PANS-AIM (ICAO Doc 10066), Chapter 5, 5.2.1.4 Specifications for AIP Supplements

Notices to airmen (NOTAMs)

Describe how information shall be published which in principle would belong to NOTAMs but includes extensive text or graphic.
Source: ICAO Annex 15, Chapter 6, 6.3.1.3, 6.3.2.1 and 6.3.2.2

Summarise the essential information which leads to the issue of a NOTAM.
Source: ICAO Annex 15, Chapter 6, 6.3.2.3

State to whom NOTAMs shall be distributed.
Source: ICAO Annex 15, Chapter 5, 5.4.2

Explain how information regarding snow, ice and standing water on AD pavements shall be reported.
Source: ICAO Annex 15, Chapter 5, 5.2.6 Note; PANS-AIM (ICAO Doc 10066), Appendix 4 Instructions for the completion of the SNOWTAM format

Describe the means by which NOTAMs shall be distributed.
Source: ICAO Annex 15, Chapter 5, 5.4 Distribution services; PANS-AIM (ICAO Doc 10066), 5.2.5 NOTAM, 5.2.5.1.3, and Appendix 7

Define and state which information an ASHTAM may contain.
Source: ICAO Annex 15, Appendix 3 ASHTAM format

Aeronautical information regulation and control (AIRAC)

List the circumstances under which the information concerned shall or should be distributed as an AIRAC.
Source: ICAO Annex 15, Chapter 6, 6.2

Aeronautical information circulars (AICs)

Describe the type of information that may be published in AICs.
Source: ICAO Annex 15, Chapter 5, 5.2.4 Aeronautical Information Circulars; PANS-AIM (ICAO Doc 10066), Chapter 5, 5.2.2 Aeronautical Information Circulars (AIC)

Explain the organisation of AICs.
Source: ICAO Annex 15, Chapter 5, 5.2.4, Note; PANS-AIM (ICAO Doc 10066), Chapter 5, 5.2.2 Aeronautical Information Circulars (AIC), 5.2.2.3 to 5.2.2.9

Pre-flight and post-flight information/data

Summarise, in addition to the elements of the integrated AIP and maps/charts, the additional current information relating to the AD of departure that shall be provided as pre-flight information.
Source: ICAO Annex 15, Chapter 5, 5.5 Pre-flight information service; PANS-AIM (ICAO Doc 10066), Chapter 5, 5.5 Pre-flight information services

Describe how a recapitulation of current NOTAM and other information of urgent character shall be made available to flight crew.

Source: ICAO Annex 15, Chapter 5, 5.5 Pre-flight information service, Note 2

State which post-flight information from flight crew shall be submitted to AIS for distribution as required by the circumstances.

Source: ICAO Annex 15, Chapter 5, 5.6 Post-flight information service

ATM service providers

ATM

State that Commission Implementing Regulation (EU) No 2017/373 provides: general requirements for the provision of air navigation services; specific requirements for the provision of air traffic services; specific requirements for the provision of meteorological services; specific requirements for the provision of aeronautical information services; specific requirements for the provision of communication, navigation or surveillance services.

AERODROMES (ICAO Annex 14, Volume I - Aerodrome Design and Operations, and Regulation (EU) No 139/2014)

General

General - AD reference code

Describe the intent of the AD reference code and state the functions of the two code elements.

Source: ICAO Annex 14, Volume 1, Chapter 1, 1.6 Reference Code

Aerodrome (AD) data

Aerodrome (AD) reference point

Describe where the AD reference point shall be located and where it shall normally remain.

Source: ICAO Annex 14, Volume 1, Chapter 2, 2.2 Aerodrome reference point

Pavement strengths

Explain the terms: 'pavement classification number (PCN)' and 'aircraft classification number (ACN)', and describe their mutual dependence.

Source: ICAO Annex 14, Volume 1, Chapter 2, 2.6 Strength of pavements

Describe how the bearing strength for an aircraft with an apron mass equal to or less than 5 700 kg shall be reported.

Source: ICAO Annex 14, Volume 1, Chapter 2, 2.6 Strength of pavements

Declared distances

State that ICAO Annex 14 provides guidance on the calculation of declared distances (TORA, TODA, ASDA, LDA). Recall the definitions for the four main declared distances.

Source: ICAO Annex 14, Volume 1, Chapter 1, 1.1 Definitions

Condition of the movement area and related facilities

State the purpose of informing AIS and ATS units about the condition of the movement area and related facilities.

Source: ICAO Annex 14, Volume 1, Chapter 2, 2.9 Condition of the movement area and related facilities

List the matters of operational significance or affecting aircraft performance which should be reported to AIS and ATS units to be transmitted to aircraft involved.

Source: ICAO Annex 14, Volume 1, Chapter 2, 2.9 Condition of the movement area and related facilities

Describe the three different types of water deposit on RWYs.

Source: ICAO Annex 14, Volume 1, Chapter 2, 2.9 Condition of the movement area and related facilities

Explain the different types of frozen water on the RWY and their impact on aircraft braking performance.

Source: ICAO Annex 14, Volume 1, Chapter 1, 1.1 Definitions and Chapter 2, 2.9 Condition of the movement area and related facilities

Describe the five levels of braking action including the associated coefficients and codes.

Source: ICAO Annex 14, Volume 1, Attachment A, 6. Assessing the surface friction characteristics of snow-, slush-, ice- and frost-covered paved surfaces

Physical characteristics

Runways (RWYs)

Describe where a THR should normally be located.

Source: ICAO Annex 14, Volume 1, Chapter 3, 3.1.5 and 3.1.6 Location of threshold

Describe the general considerations concerning RWYs associated with a stopway (SWY) or clearway (CWY).

Source: ICAO Annex 14, Volume 1, Chapter 3, 3.1.9 Runways with stopways or clearways

Runway (RWY) strips

Explain the term 'runway strip'.

Source: ICAO Annex 14, Volume 1, Chapter 3, 3.4 General, 3.4.1

Runway-end safety area

Explain the term 'runway-end safety area'.

Source: ICAO Annex 14, Volume 1, Chapter 3, 3.5 Runway end safety area 3.5.1 and 3.5.2

Clearway (CWY)
Explain the term 'clearway'.
Source: ICAO Annex 14, Volume 1, Chapter 3, 3.6 Clearways
Stopway (SWY)
Explain the term 'stopway'.
Source: ICAO Annex 14, Volume 1, Chapter 3, 3.7 Stopways
Taxiways (TWYs)
Describe the reasons and the requirements for rapid-exit TWYs .
Source: ICAO Annex 14, Volume 1, Chapter 3, 3.9 Taxiways – Rapid-exit taxiways
Explain TWY widening in curves.
Source: ICAO Annex 14, Volume 1, Chapter 3, 3.9.5 Taxiways curves
Explain when and where holding bays should be provided.
Source: ICAO Annex 14, Volume 1, Chapter 3, 3.12
Describe where RWY holding positions shall be established.
Source: ICAO Annex 14, Volume 1, Chapter 3, 3.12
Describe the term 'road holding position'.
Source: ICAO Annex 14, Volume 1, Chapter 1, 1.1 and Chapter 3, 3.12
Describe where intermediate TWY holding positions should be established.
Source: ICAO Annex 14, Volume 1, Chapter 3, 3.12
Visual aids for navigation
Indicators and signalling devices
Describe the wind-direction indicators with which ADs shall be equipped.
Source: ICAO Annex 14, Volume 1, Chapter 5, 5.1.1 Wind direction indicator (Application, Location and Characteristics)
Describe a landing-direction indicator.
Source: ICAO Annex 14, Volume 1, Chapter 5, 5.1.2 Landing direction indicator
Explain the capabilities of a signalling lamp.
State which characteristics a signal area should have.
Source: ICAO Annex 14, Volume 1, Chapter 5, 5.1.4 Signal panels and signal area, 5.1.4.1 to 5.1.4.3
Interpret all indications and signals that may be used in a signal area.
Source: Commission Implementing Regulation (EU) No 923/2012 (SERA) - Appendix 1 Signals, 3.2 Visual ground signals
Markings
Name the colours used for the various markings (RWY, TWY, aircraft stands, apron safety lines).
Source: ICAO Annex 14, Volume 1, Chapter 5, 5.2 Markings
State where a RWY designation marking shall be provided and describe the different layouts (excluding dimensions).
Source: ICAO Annex 14, Volume 1, Chapter 5, 5.2 Markings
Describe the application and general characteristics (excluding dimensions) of: RWY-centre-line markings; THR markings; touchdown-zone (TDZ) markings; RWY-side-stripe markings; TWY-centre-line markings; RWY holding position markings; intermediate holding position markings; aircraft-stand markings; apron safety lines; road holding position markings; mandatory instruction markings; information markings.
Source: ICAO Annex 14, Volume 1, Chapter 5, 5.2 Markings
Lights
Describe the mechanical safety considerations regarding elevated approach lights and elevated RWY, SWY and TWY lights.
Source: ICAO Annex 14, Volume 1, Chapter 5, 5.3.1.4 to 5.3.1.8 (Elevated approach lights, elevated lights and surface lights)
List the conditions for the installation of an aerodrome beacon (ABN) and describe its general characteristics.
Source: ICAO Annex 14, Volume 1, Chapter 5, 5.3.3 Aeronautical beacons
Describe the different kinds of operations for which a simple approach lighting system shall be used.
Source: ICAO Annex 14, Volume 1, Chapter 5, 5.3.4 Approach lighting systems
Describe the basic installations of a simple approach lighting system including the dimensions and distances normally uses.
Source: ICAO Annex 14, Volume 1, Chapter 5, 5.3.4.2
Describe the principle of a precision approach category I lighting system including information such as location and characteristics.
Source: ICAO Annex 14, Volume 1, Chapter 5, 5.3.4.10; ICAO Annex 14, Volume 1, Chapter 5, 5.3.4.14
Describe the principle of a precision approach category II and III lighting system including information such as location and characteristics, especially the inner 300 m of the system.

Source: ICAO Annex 14, Volume 1, Chapter 5, 5.3.4.22; ICAO Annex 14, Volume 1, Chapter 5, 5.3.4.30; ICAO Annex 14, Volume 1, Chapter 5, 5.3.4.31

Describe the wing bars of the precision approach path indicator (PAPI) and the abbreviated precision approach path indicator (APAPI). Interpret what the pilot will see during the approach using PAPI.

Source: ICAO Annex 14, Volume 1, Chapter 5, 5.3.5.24 to 5.3.5.27 PAPI and APAPI

Interpret what the pilot will see during an approach using a helicopter approach path indicator (HAPI).

Source: ICAO Annex 14, Volume II, Chapter 5, 5.3.6 Visual approach slope indicator

Explain the application and characteristics (as applicable, but limited to colour, intensity, direction and whether fixed or flashing) of: RWY-edge lights; RWY-THR and wing-bar lights; RWY-end lights; RWY-centre-line lights; RWY-lead-in lights; RWY-TDZ lights; SWY lights; TWY-centre-line lights; TWY-edge lights; stop bars; intermediate holding position lights; RWY guard lights; road holding position lights.

Source: ICAO Annex 14, Volume 1, Chapter 5

State the timescale within which aeronautical ground lights shall be made available to arriving aircraft.

Source: ICAO Doc 4444, Section 7.15 Aeronautical ground lights

Signs

Explain which signs are the only ones on the movement area utilising red.

Source: ICAO Annex 14, Volume 1, Chapter 5.4 Signs

List the provisions for illuminating signs.

Source: ICAO Annex 14, Volume 1, Chapter 5.4 Signs

Name the kinds of signs which shall be included in mandatory instruction signs.

Source: ICAO Annex 14, Volume 1, Chapter 5.4 Signs

Name the colours used for mandatory instruction signs.

Source: ICAO Annex 14, Volume 1, Chapter 5.4 Signs

Describe by which sign a pattern 'A' RWY holding position (i.e. at an intersection of a TWY and a non-instrument, non-precision approach or take-off RWY) marking shall be supplemented.

Source: ICAO Annex 14, Volume 1, Chapter 5.4 Signs

Describe by which sign a pattern 'B' RWY holding position (i.e. at an intersection of a TWY and a precision approach RWY) marking shall be supplemented.

Source: ICAO Annex 14, Volume 1, Chapter 5.4 Signs

Describe the location of: a RWY designation sign at a TWY/RWY intersection; a 'NO ENTRY' sign; a RWY holding position sign.

Source: ICAO Annex 14, Volume 1, Chapter 5.4 Signs

State which sign indicate~~s~~ that a taxiing aircraft is about to infringe an obstacle limitation surface or interfere with the operation of radio navigation aids (e.g. ILS/MLS critical/sensitive area).

Source: ICAO Annex 14, Volume 1, Chapter 5.4 Signs

Describe the various possible inscriptions on RWY designation signs and on holding position signs.

Source: ICAO Annex 14, Volume 1, Chapter 5.4 Signs

Describe the colours used in connection with information signs.

Source: ICAO Annex 14, Volume 1, Chapter 5.4 Signs

Describe the possible inscriptions on information signs.

Source: ICAO Annex 14, Volume 1, Chapter 5.4 Signs

Explain the application, location and characteristics of aircraft stand identification signs.

Source: ICAO Annex 14, Volume 1, Chapter 5.4 Signs

Explain the application, location and characteristics of road holding position signs.

Source: ICAO Annex 14, Volume 1, Chapter 5.4 Signs

Markers

Explain why markers located near a RWY or TWY shall be HGT limited.

Source: ICAO Annex 14, Volume 1, Chapter 5.5 Markers

Explain the application and characteristics (excluding dimensions) of: unpaved RWY-edge markers; TWY-edge markers; TWY-centre-line markers; unpaved TWY-edge markers; boundary markers; SWY-edge markers.

Source: ICAO Annex 14, Volume 1, Chapter 5.5 Markers

Visual aids for denoting obstacles

Marking of objects

State how fixed or mobile objects shall be marked if colouring is not practicable.

Source: ICAO Annex 14, Volume 1, Chapter 6, 6.2.3.1 Marking

Describe marking by colours (fixed or mobile objects).

Source: ICAO Annex 14, Volume 1, Chapter 6, 6.2.2 Mobile objects: 6.2.2.1, 6.2.2.2; 6.2.2.3; 6.2.2.4; ICAO Annex 14, Volume 1, Chapter 6, 6.2.3 Fixed objects: 6.2.3.1; 6.2.3.2; 6.2.3.3

Explain the use of markers for the marking of objects, overhead wires, cables, etc.

Source: ICAO Annex 14, Volume 1, Chapter 6, 6.2.5 Overhead wires, cables, etc., and supporting towers

Explain the use of flags for the marking of objects.
Source: ICAO Annex 14, Volume 1, Chapter 6, 6.2.3 Fixed objects: 6.2.3.5; 6.2.3.6; 6.2.3.7
Lighting of objects
Name the different types of lights to indicate the presence of objects which must be lighted.
Source: ICAO Annex 14, Volume 1, Chapter 6, 6.2 Marking and/or lighting of objects: 6.2.1.1
Describe (in general terms) the location of obstacle lights.
Source: ICAO Annex 14, Volume 1, Chapter 6, 6.2 Marking and/or lighting of objects: 6.2.1.3
Describe (in general and for normal circumstances) the colour and sequence of low-intensity obstacle lights, medium-intensity obstacle lights and high-intensity obstacle lights.
Source: ICAO Annex 14, Volume 1, Chapter 6: Table 6-1. Characteristics of obstacle lights
State that information about lights to be displayed by aircraft is provided in both ICAO Annex 2 (Rules of the Air) and SERA.
Visual aids for denoting restricted use of areas
Visual aids for denoting restricted use of areas on RWYs and TWYs
Describe the colours and meaning of 'closed markings' on RWYs and TWYs.
Source: ICAO Annex 14, Volume 1, Chapter 7, 7.1 Closed runways and taxiways, or parts thereof
State how the pilot of an aircraft moving on the surface of a TWY, holding bay or apron shall be warned that the shoulders of these surfaces are 'non-load-bearing'.
Source: ICAO Annex 14, Volume 1, Chapter 7, 7.2 Non-load-bearing surfaces
Describe the pre-THR marking (including colours) when the surface before the THR is not suitable for normal use by aircraft.
Source: ICAO Annex 14, Volume 1, Chapter 7, 7.3 Pre-threshold area
Aerodrome (AD) operational services, equipment and installations
Rescue and firefighting (RFF)
State the principal objective of RFF services.
Source: ICAO Annex 14, Volume 1, Chapter 9, 9.2 Rescue and firefighting
Explain the basic information the AD category (for RFF) depends upon.
Source: ICAO Annex 14, Volume 1, Chapter 9, 9.2 Rescue and firefighting
Describe what is meant by the term 'response time', and state its normal and maximum limits.
Source: ICAO Annex 14, Volume 1, Chapter 9, 9.2 Rescue and firefighting
Apron management service
State who has a right-of-way against vehicles operating on an apron.
Source: ICAO Annex 14, Volume 1, Chapter 9, 9.5 Apron management service
Ground-servicing of aircraft
Describe the necessary actions during the ground-servicing of an aircraft with regard to the possible event of a fuel fire.
Source: ICAO Annex 14, Volume 1, Chapter 9, 9.6 Ground servicing of aircraft
Attachment A to ICAO Annex 14, Volume 1 - Supplementary Guidance Material
Declared distances
List the four types of 'declared distances' on a RWY and also the appropriate abbreviations.
Source: ICAO Annex 14, Volume 1, Attachment A, 3. Calculation of declared distances: 3.1
Explain the circumstances which lead to the situation that the four declared distances on a RWY are equal to the length of the RWY.
Source: ICAO Annex 14, Volume 1, Attachment A, 3. Calculation of declared distances: 3.2
Describe the influence of a CWY, SWY or displaced THR upon the four 'declared distances'.
Source: ICAO Annex 14, Volume 1, Attachment A, 3. Calculation of declared distances: 3.3; 3.4; 3.5
Approach lighting systems
Name the two main groups of approach lighting systems.
Source: ICAO Annex 14, Volume 1, Attachment A, 12.1 Types and characteristics
Describe the two different versions of a simple approach lighting system.
Describe the two different basic versions of precision approach lighting systems for CAT I.
Describe the diagram of the inner 300 m of the precision approach lighting system in the case of CAT II and III.
Describe how the arrangement of an approach lighting system and the location of the appropriate THR are interrelated.
FACILITATION (ICAO Annex 9)
Entry and departure of aircraft
General declaration
Describe the purpose and use of aircraft documents as regards a 'general declaration'.
Source: ICAO Annex 9, Chapter 2 Entry and departure of aircraft, Section B Documents - requirements and use and Section D Disinsection of aircraft

Entry and departure of crew
Explain entry requirements for crew.
Source: ICAO Annex 9, Chapter 3, K. Entry procedures and responsibilities; N. Identification and entry of crew and other aircraft operators' personnel
Explain the reasons for the use of crew member certificates (CMC) for crew members engaged in international air transport.
Source: ICAO Annex 9, Chapter 3, N. Identification and entry of crew and other aircraft operators' personnel
Explain in which cases Contracting States should accept the CMC as an identity document instead of a passport or visa.
Source: ICAO Annex 9, Chapter 3, N. Identification and entry of crew and other aircraft operators' personnel
Entry and departure of passengers and baggage
Explain the entry requirements for passengers and their baggage.
Source: ICAO Annex 9, Chapter 3 Entry and departure of persons and their baggage A. General; B. Documents required for travel; F. Entry/re-entry visas; P. Emergency assistance/entry visas in cases of force majeure
Explain the requirements and documentation for unaccompanied baggage.
Source: ICAO Annex 9, Chapter 3, M. Disposition of baggage separated from its owner; ICAO Annex 9, Chapter 4, C. Release and clearance of export and import cargo
Identify the documentation required for the departure and entry of passengers and their baggage.
Source: ICAO Annex 9, Chapter 3. Entry and departure of persons and their baggage
Explain the arrangements in the event of a passenger being declared an inadmissible person.
Source: ICAO Annex 9, Chapter 5, INADMISSIBLE PERSONS AND DEPORTEES: A. General; B. Inadmissible persons
Describe the pilot's authority towards unruly passengers.
Source: ICAO Annex 9, Chapter 6, E. Unruly passengers
Entry and departure of cargo
Explain the entry requirements for cargo.
SEARCH AND RESCUE (SAR)
Essential SAR definitions
Essential SAR definitions - ICAO Annex 12
Recall the definitions of the following terms alert phase, distress phase, emergency phase, operator, PIC, rescue coordination centre, State of Registry, uncertainty phase.
Source: ICAO Annex 12, Chapter 1 Definitions
SAR - Organisation
SAR - Organisation - Establishment and provision
Describe how ICAO Contracting States shall arrange for the establishment and prompt provision of SAR services.
Source: ICAO Annex 12, Chapter 2
Explain the establishment of SAR by Contracting States.
Source: ICAO Annex 12, Chapter 2
Describe the areas within which SAR services shall be established by Contracting States.
Source: ICAO Annex 12, Chapter 2
State the period of time per day within which SAR services shall be available.
Source: ICAO Annex 12, Chapter 2
Describe for which areas rescue coordination centres shall be established.
Source: ICAO Annex 12, Chapter 2
Operating procedures for non-SAR crews
Operating procedures for non-SAR crews - PIC
Explain the SAR operating procedures for the PIC who arrives first at the scene of an accident.
Source: ICAO Annex 12, Chapter 5, 5.6 Procedures at thescene of an accident
Explain the SAR operating procedures for the PIC intercepting a distress transmission.
Source: ICAO Annex 12, Chapter 5, 5.7 Procedures for a pilot-in-command intercepting a distress transmission
Search and rescue signals
Search and rescue signals - Survivors
Explain the 'ground–air visual signal code' for use by survivors.
Source: ICAO Annex 12, Chapter 5.8 Search and rescue signals and Appendix
Recognise the SAR 'air-to-ground signals' for use by survivors.
Source: ICAO Annex 12, Chapter 5.8 Search and rescue signals and Appendix
SECURITY - Safeguarding International Civil Aviation against Acts of Unlawful Interference (ICAO Annex 17)
Essential definitions of ICAO Annex 17
Essential definitions of ICAO Annex 17

Recall the definitions of the following terms airside, aircraft security check, screening, security, security control, security-restricted area, unidentified baggage.

Source: ICAO Annex 17, Chapter 1 Definitions

General principles

General principles - Objectives of security

State the objectives of security.

Source: ICAO Annex 17, Chapter 2, 2.1 Objectives

Preventive security measures

Preventive security measures

Describe the objects not allowed (for reasons of aviation security) on board an aircraft that is engaged in international civil aviation.

Source: ICAO Annex 17, Chapter 4, 4.1 Objective

State what each Contracting State is supposed to do if passengers subjected to security control have mixed after a security screening point.

Source: ICAO Annex 17, Chapter 4, 4.4 Measures relating to passengers and their cabin baggage

Explain what has to be done when passengers who are obliged to travel because of judicial or administrative proceedings are supposed to board an aircraft.

Source: ICAO Annex 17, Chapter 4, 4.7 Measures relating to special categories of passengers

Explain what has to be considered if law enforcement officers carry weapons on board.

Source: ICAO Annex 17, Chapter 4, 4.7 Measures relating to special categories of passengers

Management of response to acts of unlawful interference

Management of response to acts of unlawful interference

Describe the assistance each Contracting State shall provide to an aircraft subjected to an act of unlawful seizure.

Source: ICAO Annex 17, Chapter 5, 5.2 Response

State the circumstances which could prevent a Contracting State from detaining an aircraft on the ground after being subjected to an act of unlawful seizure.

Source: ICAO Annex 17, Chapter 5, 5.2 Response

Operators' security programme

Operators' security programme - Principles

Describe the principles of the written operator's security programme each Contracting State requires from operators.

Source: ICAO Annex 17, Chapter 3, 3.3 Aircraft operators

Security procedures in other documents, i.e. ICAO Annexes 2, 6 and 14, ICAO Doc 4444, Regulation (EU) No 965/2012 and CS-ADR-DSN

ICAO Annex 2 - Rules of the Air, including Attachment B - Unlawful interference

Describe what the PIC should do, in a situation of unlawful interference, unless considerations aboard the aircraft dictate otherwise.

Source: ICAO Annex 2, Chapter 3, 3.7 Unlawful interference

Describe what the PIC, of an aircraft subjected to unlawful interference, should do if the aircraft must depart from its assigned track; the aircraft must depart from its assigned cruising level; the aircraft is unable to notify an ATS unit of the unlawful interference.

Source: ICAO Annex 2, Attachment B 'Unlawful interference'

Describe what the PIC should attempt to do with regard to broadcast warnings and the level at which to proceed, in a situation of unlawful interference, if no applicable regional procedures for in-flight contingencies have been established.

Source: ICAO Annex 2, Attachment B 'Unlawful interference'

ICAO Annex 6 - Operation of Aircraft Chapter 13 - Security

Describe the special considerations referring to flight crew compartment doors with regard to aviation security.

Source: ICAO Annex 6, Part I — International Commercial Air Transport — Aeroplanes, Chapter 13, 13.2 Security of the flight crew compartment

ICAO Annex 14 Volume I - Aerodromes Chapter 3 - Physical characteristics

Describe what minimum distance an isolated aircraft parking position (after the aircraft has been subjected to unlawful interference) should have from other parking positions, buildings or public areas.

Source: ICAO Annex 14 Volume I, Chapter 3, 3.14 Isolated aircraft parking position

ICAO Doc 4444 - Air Traffic Management

Describe the considerations that must take place with regard to a taxi clearance in case an aircraft is known or believed to have been subjected to unlawful interference.

Source: ICAO Doc 4444, Chapter 15, 15.1.3 Unlawful interference and aircraft bomb threat

AIRCRAFT ACCIDENT AND INCIDENT INVESTIGATION

Essential definitions of ICAO Annex 13

Definitions and descriptions

Recall the definitions of the following terms: accident, aircraft, flight recorder, incident, investigation, maximum mass, operator, serious incident, serious injury, State of Design, State of Manufacture, State of Occurrence, State of the Operator, State of Registry.

Source: ICAO Annex 13, Chapter 1 Definitions

Explain the difference between 'serious incident' and 'accident'.

Source: ICAO Annex 13, Chapter 1 Definitions and Attachment C 'List of examples of serious incidents'

Determine whether a certain occurrence has to be defined as a serious incident or as an accident.

Source: ICAO Annex 13, Chapter 1 Definitions and Attachment C 'List of examples of serious incidents'

Recognise the description of an accident or incident.

Source: ICAO Annex 13, Chapter 1 Definitions

Accident and incident investigation in ICAO Annex 13

Objectives and procedures

State the objective(s) of the investigation of an accident or incident according to ICAO Annex 13.

Source: ICAO Annex 13, Chapter 3, 3.1 Objective of the investigation

Describe the general procedures for the investigation of an accident or incident according to ICAO Annex 13.

Source: ICAO Annex 13, Chapter 4, 4.1; ICAO Annex 13, Chapter 5, 5.1 to 5.4.1

Accident and incident investigation in EU regulations

Occurrences

Identify an occurrence as being either an accident, incident or serious incident in Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation.

Source: Regulation (EU) No 996/2010, Article 2(1), (7) and (16) and Annex 'List of examples of serious incidents'

Describe the relationship between Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and Regulation (EU) No 376/2014 of the European Parliament and of the Council of 3 April 2014 on the reporting, analysis and follow-up of occurrences in civil aviation.

Source: Regulation (EU) No 376/2014, p. L122/18 (3) and p. L122/21 (28); Regulation (EU) No 996/2010

State the subject matter and scope of Regulation (EU) No 376/2014 (Article 3).

Source: Regulation (EU) No 376/2014, Article 3

Identify occurrences that must be reported (Regulation (EU) No 376/2014, Article 4).

Source: Regulation (EU) No 376/2014, Article 4

Identify occurrences that should be voluntarily reported (Regulation (EU) No 376/2014, Article 5).

Source: Regulation (EU) No 376/2014, Article 5

Describe how information from occurrences is collected, stored and analysed (Regulation (EU) No 376/2014, Articles 6, 8, 13 and 14).

Source: Regulation (EU) No 376/2014, Articles 6, 8, 13 and 14

021. AIRCRAFT GENERAL KNOWLEDGE - AIRFRAME, SYSTEMS AND POWER PLANT SYSTEM DESIGN, LOADS, STRESSES, MAINTENANCE - number of lectures / time: 19 hours. (+4 hours online session)

Design concepts

Describe the following structural design philosophy: safe life; fail-safe (multiple load paths); damage-tolerant.

Explain the purpose of redundancy in aircraft design.

Level of certification

Explain why some systems are duplicated or triplicated.

Explain that all aircraft are certified according to specifications determined by the competent authority, and that these certification specifications cover aspects such as design, material quality and build quality.

State that the certification specifications for aeroplanes issued by EASA are: CS-23 for Normal, Utility, Aerobatic and Commuter Aeroplanes; CS-25 for Large Aeroplanes.

State that the certification specifications for rotorcraft issued by EASA are: CS-27 for Small Rotorcraft; CS-29 for Large Rotorcraft.

Loads and stresses

Stress, strain and loads

Explain how stress and strain are always present in an aircraft structure both when parked and during manoeuvring. Remark: Stress is the internal force per unit area inside a structural part as a result of external loads. Strain is the deformation caused by the action of stress on a material.

Describe the following types of loads that an aircraft may be subjected to, when they occur, and how a pilot may affect their magnitude: static loads; dynamic loads; cyclic loads.

Describe the areas typically prone to stress that should be given particular attention during a pre-flight inspection, and highlight the limited visual cues of any deformation that may be evident.

Fatigue and corrosion

Describe and explain fatigue and corrosion

Describe the effects of corrosion and how it can be visually identified by a pilot during the pre-flight inspection.

Describe the operating environments where the risk of corrosion is increased and how to minimise the effects of the environmental factors.

Explain that aircraft have highly corrosive fluids on board as part of their systems and equipment.

Explain fatigue, how it affects the useful life of an aircraft, and the effect of the following factors on the development of fatigue: corrosion; number of cycles; type of flight manoeuvres; stress level; level and quality of maintenance.

Maintenance

Maintenance methods: hard-time and on-condition monitoring

Explain the following terms: hard-time or fixed-time maintenance; on-condition maintenance; condition monitoring.

AIRFRAME

Attachment methods

Attachment methods and detecting the development of faulty attachments

Describe the following attachment methods used for aircraft parts and components: riveting; welding; bolting; pinning; adhesives (bonding); screwing.

Explain how the development of a faulty attachment between aircraft parts or components can be detected by a pilot during the pre-flight inspection.

Materials

Composite and other materials

Explain the principle of a composite material, and give examples of typical non-metallic materials used on aircraft: carbon; glass; Kevlar aramid; resin or filler.

State the advantages and disadvantages of composite materials compared with metal alloys by considering the following: strength-to-weight ratio; capability to tailor the strength to the direction of the load; stiffness; electrical conductivity (lightning); resistance to fatigue and corrosion; resistance to cost; discovering damage during a pre-flight inspection.

State that several types of materials are used on aircraft and that they are chosen based on type of structure or component and the required/desired material properties.

Aeroplane: wings, tail surfaces and control surfaces

Design

Describe the following types of design and explain their advantages and disadvantages: high-mounted wing; low-mounted wing; low- or mid-set tailplane; T-tail.

Structural components

Describe the function of the following structural components: spar and its components (web and girder or cap); rib; stringer; skin; torsion box.

Loads, stresses and aeroelastic vibrations (flutter)

Describe the vertical and horizontal loads on the ground and during normal flight.

Describe the vertical and horizontal loads during asymmetric flight following an engine failure for a multi-engine aeroplane, and how a pilot may potentially overstress the structure during the failure scenario.

Explain the principle of flutter and resonance for the wing and control surfaces.

Explain the following countermeasures used to achieve stress relief and reduce resonance: chord-wise and span-wise position of masses (e.g. engines, fuel, balance masses for wing and control balance masses); torsional stiffness; bending flexibility; fuel-balancing procedures during flight (automatic or applied by the pilot).

Fuselage, landing gear, doors, floor, windscreen and windows

Construction, functions, loads

Describe the following types of fuselage construction: monocoque, semi-monocoque.

Describe the construction and the function of the following structural components of a fuselage: frames; bulkhead; pressure bulkhead; stiffeners, stringers, longerons; skin, doublers; floor suspension (crossbeams); floor panels; firewall.

Describe the loads on the fuselage due to pressurisation.

Describe the following loads on a main landing gear: touch-down loads (vertical and horizontal); taxi loads on bogie gear (turns).

Describe the structural danger of a nose-wheel landing with respect to: fuselage loads; nose-wheel strut loads.

Describe the structural danger of a tail strike with respect to: fuselage and aft bulkhead damage (pressurisation).

Describe the door and hatch construction for pressurised and unpressurised aeroplanes including: door and frame (plug type); hinge location; locking mechanism.

Explain the advantages and disadvantages of the following fuselage cross sections: circular; double bubble; oval; rectangular.
Explain why flight-deck windows are constructed with different layers.
Explain the function of window heating for structural purposes.
Explain the implication of a direct-vision window (see CS 25.773(b)(3)).
Explain the need for an eye-reference position.
Explain the function of floor venting (blow-out panels).
Describe the construction and fitting of sliding doors.

HYDRAULICS

Hydromechanics: basic principles

Concepts and basic principles

Explain the concept and basic principles of hydromechanics including: hydrostatic pressure; Pascal's law; the relationship between pressure, force and area; transmission of power: multiplication of force, decrease of displacement.

Hydraulic systems

Hydraulic fluids: types, characteristics, limitations

List and explain the desirable properties of a hydraulic fluid with regard to: thermal stability; corrosiveness; flashpoint and flammability; volatility; viscosity.
State that hydraulic fluids are irritating to skin and eyes.
List the two different types of hydraulic fluids: synthetic; mineral.
State that different types of hydraulic fluids cannot be mixed.
State that at the pressures being considered, hydraulic fluid is considered incompressible.

System components: design, operation, degraded modes of operation, indications and warnings

Explain the working principle of a hydraulic system.
Describe the difference in the principle of operation between a constant pressure system and a system pressurised only on specific demand.
State the differences in the principle of operation between a passive hydraulic system (without a pressure pump) and an active hydraulic system (with a pressure pump).
List the main advantages and disadvantages of system actuation by hydraulic or purely mechanical means with respect to: weight; size; force.
List the main uses of hydraulic systems.
State that hydraulic systems can be classified as either high pressure (typically 3000 psi or higher) or low pressure (typically up to 2000 psi).
State that a high-pressure hydraulic system is typically operating at 3000 psi but on some aircraft a hydraulic pressure of 4000 to 5000 psi may also be used.
Explain the working principle of a low-pressure (0–2000 psi) system.
Explain the advantages and disadvantages of a high-pressure system over a low-pressure system.
Describe the working principle and functions of pressure pumps including: constant pressure pump (swash plate or cam plate); pressure pump whose output is dependent on pump revolutions per minute (rpm) (gear type).
Explain the following different sources of hydraulic pressure, their typical application and potential operational limitations: manual; engine gearbox; electrical; air (pneumatic and ram-air turbine); hydraulic (power transfer unit) or reversible motor pumps; accessory.
Explain the following different sources of hydraulic pressure, their typical application and potential operational limitations: manual; engine; gearbox; electrical.
Describe the working principle and functions of the following hydraulic system components: reservoir (pressurised and unpressurised); accumulators; case drain lines and fluid cooler return lines; piston actuators (single- and double-acting); hydraulic motors; filters; non-return (check) valves; relief valves; restrictor valves; selector valves (linear and basic rotary selectors, two and four ports); bypass valves; shuttle valves; fire shut-off valves; priority valves; fuse valves; pressure and return pipes.
Explain the function of the demand pump installed on many transport aeroplanes.
Explain how redundancy is obtained by giving examples.
Interpret a typical hydraulic system schematic to the level of detail as found in an aircraft flight crew operating manual (FCOM).
Explain the implication of a high system demand.
List and describe the instruments and alerts for monitoring a hydraulic system.
State the indications and explain the implications of the following malfunctions: system leak or low level; low pressure; high temperature.

LANDING GEAR, WHEELS, TYRES, BRAKES

Landing gear

Types

Name, for an aeroplane, the following different landing-gear configurations: nose wheel; tail wheel.
System components, design, operation, indications and warnings, on-ground/in-flight protections, emergency extension systems
Explain the function of the following components of a landing gear: oleo leg/shock strut; axles; bogies and bogie beam; drag struts; side stays/struts; torsion links; locks (over centre); gear doors.
Explain the function of the following components of a landing gear: oleo leg/shock strut; axles; drag struts; side stays/struts; torsion links; locks (over centre); gear doors.
Name the different components of a landing gear, using the diagram appended to these LOs (021).
Describe the sequence of events during normal operation of the landing gear.
State how landing-gear position indication and alerting is implemented.
Describe the various protection devices to avoid inadvertent gear retraction on the ground and explain the implications of taking off with one or more protection devices in place: ground lock (pins); protection devices in the gear retraction mechanism.
Explain the speed limitations for gear operation (VLO (maximum landing gear operating speed) and VLE (maximum landing gear extended speed)).
Describe the sequence for emergency gear extension: unlocking; operating; down-locking.
Describe some methods for emergency gear extension including: gravity/free fall; air or nitrogen pressure; manually/mechanically.
Nose-wheel steering
Design, operation
Explain the operating principle of nose-wheel steering.
Describe, for an aeroplane, the functioning of the following systems: differential braking with free-castoring nose wheel; tiller or hand wheel steering; rudder pedal nose-wheel steering.
Explain the centring mechanism of the nose wheel.
Define the term ‘shimmy’ and the possible consequences of shimmy for the nose- and the main-wheel system and explain the purpose of a shimmy damper to reduce the severity of shimmy.
Explain the purpose of main-wheel (body) steering.
Brakes
Types and materials
Describe the basic operating principle of a disc brake.
State the different materials used in a disc brake (steel, carbon).
Describe the characteristics, advantages and disadvantages of steel and carbon brake discs with regard to: weight; temperature limits; internal-friction coefficient; wear.
System components, design, operation, indications and warnings
Explain the limitation of brake energy and describe the operational consequences.
Explain how brakes are actuated: hydraulically, electrically.
Explain the purpose of an in-flight wheel brake system.
Describe the function of a brake accumulator.
Describe the function of the parking brake.
Explain the function of brake-wear indicators.
Explain the reason for the brake-temperature indicator.
Anti-skid
Describe the operating principle of anti-skid wher excessive brake pressure applied is automatically reduced for optimum breaking performance.
Explain that the anti-skid computer compares wheel speed to aeroplane reference speed to provide the following: slip ratio for maximum braking performance; locked-wheel prevention (protection against deep skid on one wheel); touchdown protection (protection against brake-pressure application during touchdown); hydroplane protection.
Give examples of the impact of an anti-skid system on performance, and explain the implications of anti-skid system failure.
Autobrake
Describe the operating principle of an autobrake system.
Explain why the anti-skid system must be available when using autobrakes.
Explain the difference between the three modes of operation of an autobrake system: OFF (system off or reset); Armed (the system is ready to operate under certain conditions); Activated/Deactivated (application of pressure on brakes).
Describe how an autobrake system setting will either apply maximum braking (RTO or MAX) or result in a given rate of deceleration, where the amount of braking applied may be affected by: the use of reverse thrust; slippery runway.
Wheels, rims and tyres
Types, structural components and materials, operational limitations, thermal plugs

Describe the different types of tyres such as: tubeless; diagonal (cross ply); radial (circumferential bias).
Define the following terms: ply rating; tyre tread; tyre creep; retread (cover).
Explain the function of thermal/fusible plugs.
Explain the implications of and how to identify tread separation and wear or damage with associated increased risk of tyre burst.
Explain why the ground speed of tyres is limited.
Describe the following tyre checks a pilot will perform during the pre-flight inspection and identify probable causes: cuts and damages; flat spots.

FLIGHT CONTROLS

Aeroplane: primary flight controls

Definition and control surfaces

Define a 'primary flight control'.
List the following primary flight control surfaces: elevator, aileron, roll spoilers, flaperon; rudder.
List the various means of control surface actuation including: manual; fully powered (irreversible); partially powered (reversible).

Manual controls

Explain the basic principle of a fully manual control system.

Fully powered controls (irreversible)

Explain the basic principle of a fully powered control system.
Explain the concept of irreversibility in a flight control system.
Explain the need for a 'feel system' in a fully powered control system.
Explain the operating principle of a stabiliser trim system in a fully powered control system.
Explain the operating principle of rudder and aileron trim in a fully powered control system.

Partially powered controls (reversible)

Explain the basic principle of a partially powered control system.
Explain why a 'feel system' is not necessary in a partially powered control system.

System components, design, operation, indications and warnings, degraded modes of operation, jamming

List and describe the function of the following components of a flight control system: actuators; control valves; cables; electrical wiring; control surface position sensors.
Explain how redundancy is obtained in primary flight control systems of large transport aeroplanes.
Explain the danger of control jamming and the means of retaining sufficient control capability.
Explain the methods of locking the controls on the ground and describe 'gust or control lock' warnings.
Explain the concept of a rudder deflection limitation (rudder limiter) system and the various means of implementation (rudder ratio changer, variable stops, blow-back).

Aeroplane: secondary flight controls

System components, design, operation, degraded modes of operation, indications and warnings

Define a 'secondary flight control'.
List the following secondary flight control surfaces: lift-augmentation devices (flaps and slats); speed brakes; flight and ground spoilers; trimming devices such as trim tabs, trimmable horizontal stabiliser.
Describe secondary flight control actuation methods and sources of actuating power.
Explain the function of a mechanical lock when using hydraulic motors driving a screw jack.
Describe the requirement for limiting flight speeds for the various secondary flight control surfaces.
For lift-augmentation devices, explain the load-limiting (relief) protection devices and the functioning of an auto-retraction system.
Explain how a flap/slat asymmetry protection device functions, and describe the implications of a flap/slat asymmetry situation.
Describe the function of an auto-slat system.
Explain the concept of control surface blow-back (aerodynamic forces overruling hydraulic forces).
Describe the operation of the spider control system.
State the need for artificial feel in ~~a~~ hydraulically actuated flight control system.
Describe and explain the purpose of a trim system using the following terms: force-trim switch; force gradient; parallel trim actuator; cyclic 4-way trim switch; interaction of trim system with an SAS/SCAS/ASS stability system; trim-motor indicators.
Describe the different types of control runs.
Explain the use of control stops.

Aeroplane: fly-by-wire (FBW) control systems

Composition, explanation of operation, modes of operation

Explain that an FBW flight control system is composed of the following: pilot's input command (control column/sidestick/rudder pedals); electrical signalling paths, including: pilot input to computer, computer to flight

control surfaces, feedback from aircraft response to computer; flight control computers; actuators; flight control surfaces.
State the advantages of an FBW system in comparison with a conventional flight control system including: weight; pilot workload; flight-envelope protection.
Explain why an FBW system is always irreversible.
Explain the different modes of operation: normal operation (e.g. normal law or normal mode); downgraded operation (e.g. alternate law or secondary mode); direct law.
Describe the implications of mode degradation in relation to pilot workload and flight-envelope protection.
For aircraft using sidestick for manual control, describe the implications of: dual control input made by the pilot; the control takeover facility available to the pilot.
Explain why several types of computers are needed and why they should be dissimilar.
Explain why several control surfaces on every axis are needed on FBW aircraft.
Explain why several sensors are needed on critical parameters.

PNEUMATICS - PRESSURISATION AND AIR-CONDITIONING SYSTEMS

Pneumatic/bleed-air supply

Piston-engine air supply

Describe the following means of supplying air for the pneumatic systems for piston-engine aircraft: compressor; vacuum pump.
State that an air supply is required for the following systems: instrumentation; heating; de-icing.

Gas turbine engine: bleed-air supply

State that the possible bleed-air sources for gas turbine engine aircraft are the following: engine; auxiliary power unit (APU); ground supply.
State that for an aeroplane a bleed-air supply can be used for the following systems or components: ice protection; engine air starter; pressurisation of a hydraulic reservoir; air-driven hydraulic pumps; pressurisation and air conditioning.
State that the bleed-air supply system can comprise the following: pneumatic ducts; isolation valve; pressure-regulating valve; engine bleed valve (HP/IP valves); fan-air pre-cooler; temperature and pressure sensors.
Interpret a basic pneumatic system schematic to the level of detail as found in an FCOM.
Describe the cockpit indications for bleed-air systems.
How the bleed-air supply system is controlled and monitored.
State the following bleed-air malfunctions: over-temperature; over-pressure; low pressure; overheat/duct leak; and describe the potential consequences.

Aeroplane: pressurisation and air-conditioning system

System components, design, operation, degraded modes of operation, indications and warnings

Explain that a pressurisation and an air-conditioning system of an aeroplane controls: ventilation; temperature; pressure.
Explain how humidity is controlled.
Explain that the following components constitute a pressurisation system: pneumatic system as the power source; outflow valve; outflow valve actuator; pressure controller; excessive differential pressure-relief valve; negative differential pressure-relief valve.
Explain that the following components constitute an air-conditioning system and describe their operating principles and function: air-cycle machine (pack, bootstrap system); pack-cooling fan; water separator; mixing valves; flow-control valves (outflow valve); isolation valves; ram-air valve; recirculation fans; filters for recirculated air; temperature sensors. *Remark: The bootstrap system is the only air-conditioning system considered for Part-FCL aeroplane examinations.*
Describe the use of hot trim air.
Define the following terms: cabin altitude; cabin vertical speed; differential pressure; ground pressurisation.
Describe the operating principle of a pressurisation system.
Describe the emergency operation by manual setting of the outflow valve position.
Describe the working principle of an electronic cabin-pressure controller.
State how the maximum operating altitude is determined.
Explain: why the maximum allowed value of cabin altitude is limited; a typical value of maximum differential pressure for large transport aeroplanes; the relation between cabin altitude, the maximum differential pressure and maximum aeroplane operating altitude.
Explain the typical warning on a transport category aircraft when cabin altitude exceeds 10 000 ft.
List and interpret typical indications of the pressurisation system.
Describe the main operational differences between a bleed-air-driven air-conditioning system and an electrically driven air-conditioning system as found on aircraft without engine bleed-air system.

ANTI-ICING AND DE-ICING SYSTEMS

Types, operation, indications

Types, design, operation, indications and warnings, operational limitations
Explain the concepts of anti-icing and de-icing.
Name the components of an aircraft which can be protected from ice accretion.
State that on some aeroplanes the tail does not have an ice-protection system.
State the different types of anti-icing/de-icing systems and describe their operating principle: hot air; electrical; fluid.
Describe the operating principle of the inflatable boot de-icing system.
Ice warning systems
Types, operation, and indications
Describe the different operating principles of the following ice detectors: mechanical systems using air pressure; electromechanical systems using resonance frequencies.
Describe the principle of operation of ice warning systems.
FUEL SYSTEM
Piston engine
Fuel: types, characteristics, limitations
State the types of fuel used by a piston engine and their associated limitations: diesel; JET-A1 (for high-compression engines); AVGAS; MOGAS.
State the main characteristics of these fuels and give typical values regarding their flash points, freezing points and density.
Design, operation, system components, indications
State the tasks of the fuel system.
Name the following main components of a fuel system, and state their location and their function: lines; boost pump; pressure valves; filter, strainer; tanks (wing, tip, fuselage); vent system; sump; drain; fuel-quantity sensor; fuel-temperature sensor.
Describe a gravity fuel feed system and a pressure feed fuel system.
Describe the construction of the different types of fuel tanks and state their advantages and disadvantages: drum tank; bladder tank; integral tank.
Explain the function of cross-feed.
Define the term 'unusable fuel'.
List the following parameters that are monitored for the fuel system: fuel quantity (low-level warning); fuel temperature.
Turbine engine
Fuel: types, characteristics, limitations
State the types of fuel used by a gas turbine engine: JET-A; JET-A1; JET-B.
State the main characteristics of these fuels and give typical values regarding their flash points, freezing points and density.
State the existence of additives for freezing.
Design, operation, system components, indications
Explain the function of the fuel system: lines; centrifugal boost pump; pressure valves; fuel shut-off valve; filter, strainer; tanks (wing, tip, fuselage, tail); bafflers/baffles; sump; vent system; drain; fuel-quantity sensor; fuel-temperature sensor; refuelling/defueling system; fuel dump/jettison system.
Name the main components of the fuel system and state their location and their function: trim fuel tanks; bafflers; refuelling/defueling system; fuel dump/jettison system. *Remark: For completion of list, please see 021 08 01 02 (02).*
Interpret a typical fuel system schematic to the level of detail as found in an aircraft FCOM.
Explain the limitations in the event of loss of booster pump fuel pressure.
Describe the use and purpose of drip sticks (manual magnetic indicators) (may also be known as dip stick or drop stick).
Explain the considerations for fitting a fuel dump/jettison system and, if fitted, its function.
ELECTRICS
General, definitions, basic applications: circuit breakers, logic circuits
Static electricity
Explain static electricity and describe the flying conditions where aircraft are most susceptible to build-up of static electricity.
Describe a static discharger and explain the following: its purpose; typical locations; pilot's role of observing it during pre-flight inspection.
Explain why an aircraft must first be grounded before refuelling/defueling.
Explain the reason for electrical bonding.
Direct current (DC)
Explain the term 'direct current' (DC), and state that current can only flow in a closed circuit.

Explain the basic principles of conductivity and give examples of conductors, semiconductors and insulators.
Describe the difference in use of the following mechanical switches and explain the difference in observing their state (e.g. ON/OFF), and why some switches are guarded: toggle switch; rocker switch; pushbutton switch; rotary switch. Explain the difference in observing their state (e.g. ON/OFF) and why some switches are guarded.
Define voltage and current, and state their unit of measurement.
Explain Ohm's law in qualitative terms.
Explain the effect on total resistance when resistors are connected in series or in parallel.
State that resistances can have a positive or a negative temperature coefficient (PTC/NTC) and state their use.
Define electrical power and state the unit of measurement.

Alternating current (AC)

Explain the term 'alternating current' (AC), and compare its use to DC with regard to complexity.
Define the term 'phase', and explain the basic principle of single-phase and three-phase AC.
State that aircraft can use single-phase or three-phase AC.
Define frequency and state the unit of measurement.
Define 'phase shift' in qualitative terms.

Electromagnetism

State that an electrical current produces a magnetic field.
Describe how the strength of the magnetic field changes with the magnitude of the current.
Explain the purpose and the working principle of a solenoid.
Explain the purpose and the working principle of a relay.
Explain the principle of electromagnetic induction and how two electrical components or systems may affect each other through this principle.

Circuit protection

Explain the working principle of a fuse and a circuit breaker.
Explain how a fuse is rated.
Describe the principal difference between the following types of circuit breakers: thermal circuit breaker sensing magnitude of current; magnetic circuit breaker sensing direction of current.
Describe how circuit breakers may be used to reset aircraft systems/computers in the event of system failure (when part of a described procedure).
Explain a short circuit in practical terms using Ohm's Law, power and energy expressions highlighting the risk of fire due to power transfer and extreme energy dissipation.
Explain the risk of fire resulting from excessive heat in a circuit subjected to overcurrent.
Explain that overcurrent situations may be transient.
Explain the hazards of multiple resets of a circuit breaker or the use of incorrect fuse rating when replacing blown fuses.

Semiconductors and logic circuits

Describe the effect of temperature on semiconductors with regard to function and longevity of the component.
Describe the following five basic logic functions, as used in aircraft FCOM documentation, and recognise their schematic symbols according to the ANSI/MIL standard: AND; OR; NOT; NOR; NAND.
Interpret a typical logic circuit schematic to the level of detail as found in an aircraft FCOM.

Batteries

Types, characteristics and limitations

State the function of an aircraft battery.
Name the types of rechargeable batteries used in aircraft: lead-acid; nickel-cadmium; lithium-ion; lithium-polymer.
Compare the different battery types with respect to: load behaviour; charging characteristics; risk of thermal runaway.
Explain the term 'cell voltage' and describe how a battery may consist of several cells that combined provide the desirable voltage and capacity.
Explain the difference between battery voltage and charging voltage.
Define the term 'capacity of batteries' and state the unit of measurement used.
State the effect of temperature on battery capacity and performance.
State that in the case of loss of all generated power (battery power only) the remaining electrical power is time-limited.
Explain how lithium-type batteries pose a threat to aircraft safety and what affects this risk: numbers of batteries on board an aircraft including those brought on board by passengers; temperature, of both battery and environment; physical condition of the battery; battery charging.
Describe how to contain a battery thermal runaway highlighting the following: how one cell can affect the neighbouring cells; challenges if it happens in an aircraft during flight.

Generation

Remark: For standardisation purposes, the following standard expressions are used:

— DC generator: produces DC output;
— DC alternator: produces AC, rectified by integrated rectifying unit, the output is DC;
— DC alternator: producing a DC output by using a rectifier;
— AC generator: produces AC output;
— starter generator: integrated combination of a generator and a starter motor;
— permanent magnet alternator/ generator: self-exciting AC generator.

DC generation

Describe the basic working principle of a simple DC generator or DC alternator.
Explain the principle of voltage control and why it is required.
Explain the purpose of reverse current ~~protection~~ from the battery~~/busbar to the alternator~~.
Describe the basic operating principle of a starter generator and state its purpose.

AC generation

Describe the working principle of a brushless three-phase AC generator.
State that the generator field current is used to control voltage.
State the relationship between output frequency and the rpm of a three-phase AC generator.
Explain the term 'frequency wild generator'.
List the following different power sources that can be used for an aeroplane to drive an AC generator: engine; APU; RAT; hydraulic.

Constant speed drive (CSD) and integrated drive generator (IDG) systems

Describe the function of a CSD.
Explain the parameters of a CSD that are monitored.
Describe the function of an IDG.
Explain the consequences of a mechanical disconnection during flight for a CSD and an IDG.
Explain that a CSD/IDG has its own, independent oil system and how a leak from this may appear as an engine oil leak.

Transformers, transformer rectifier units (TRUs), static inverters

State the function of a transformer.
State the function of a TRU and its purpose, including type of output.
State the function of a static inverter and its purpose, including type of output.

Distribution

General

Explain the function of a busbar.
Describe the function of the following buses: AC bus; DC bus; emergency AC or DC bus; essential AC or DC bus; battery bus; hot bus, ground servicing or maintenance bus.
State that the aircraft structure can be used as a part of the electrical circuit (common earth) and explain the implications for electrical bonding.
Explain the function of external power.
State that a priority sequence exists between the different sources of electrical power on ground and in flight.
Explain the term 'load sharing'.
Explain the term 'load shedding'.
Describe typical systems that can be shed in the event of a supply failure, such as passenger entertainment system and galley power.
Interpret a typical electrical system schematic to the level of detail as found in an aircraft FCOM.
Explain the difference between a supply (e.g. generator) failure and a bus failure, and the operating consequences of either.

DC distribution

Describe a simple DC electrical system of a single-engine aircraft.
Describe a DC electrical system of a multi-engine aircraft (CS-23/CS-27) including the distribution consequences of loss of generator(s) or bus failure.
Describe the DC part of an electrical system of a transport aircraft (CS-25/CS-29) including the distribution consequences of loss of DC supply or bus failure.
Give examples of DC consumers.

AC distribution

Explain the difference in the principle of operation for a split AC electrical system and a parallel AC electrical system.
Describe the following distribution consequences: power transfer between different power supplies; power transfer in the event of a supply failure; loss of all normal AC supplies.
Give examples of AC consumers.

Explain the conditions to be met for paralleling AC generators.
State that volt-ampere (VA) is the unit for total power consumed in an AC system.
Electrical load management and monitoring systems: automatic generators and bus switching during normal and failure operation, indications and warnings
Give examples of system control, monitoring and annunciators using the following terms: generator control unit (GCU) for monitoring generator output and providing network protection; exciter contactor/breaker/relay for control of generator exciter field; generator contactor/breaker/relay for connecting the generator to the network; bus-tie contactor/breaker/relay for connecting busbars together; generator switch on the flight deck for manual control of exciter contactor; IDG/CSD disconnect switch on the flight deck for mechanical disconnection of the generator; bus-tie switch on the flight deck with AUTO and OFF positions only.
Describe, for normal and degraded modes of operation, the following functions of an electrical load management system on ground and in flight using the terms in 021 09 04 04 (01): distribution; monitoring; protection in the event of incorrect voltage; protection in the event of incorrect frequency; protection in the event of a differential fault.
Describe the requirement for monitoring the aircraft batteries.
Explain the importance of monitoring the temperature of nickel-cadmium and lithium-type batteries.
Interpret various different ammeter indications of an ammeter which monitors the charge current of the battery.
Electrical motors
General
State that the purpose of an electrical motor is to convert electrical energy into mechanical energy.
State that because of the similarity in design, a generator and an electrical motor may be combined into a starter generator.
Explain that the size of the engine determines how much energy is required for starting, and state the following: small turbine engines may be able to use the battery for a very limited number of start attempts; large turbine engines require one or more power sources, either external or on-board.
Operating principle
Describe how the torque of an electrical motor is determined by the supplied voltage and current, and the resulting magnetic fields within the engine.
State that electrical motors can be either AC or DC.
Explain the consequences of the following: rotor seizure; rotor runaway.
Components
Name the following components of an electrical motor: rotor (rotating part of an electrical motor); stator (stationary part of an electrical motor).
PISTON ENGINES
Remark: This topic includes diesel engines and petrol engines
General
Types of internal-combustion engines: basic principles, definitions
Define the following terms and expressions: rpm; torque; manifold absolute pressure (MAP); power output; specific fuel consumption; compression ratio, clearance volume, swept (displaced) volume, total volume.
Engine: design, operation, components
Describe the basic operating principle of a piston engine: crankcase; crankshaft; connecting rod; piston; piston pin; piston rings; cylinder; cylinder head; valves; valve springs; push rod; camshaft; rocker arm; camshaft gear; bearings.
Name and identify the various types of engine design with regard to cylinder arrangement and their advantages/disadvantages: horizontally opposed; in line; radial; and working cycle (four stroke: petrol and diesel).
Describe the differences between petrol and diesel engines with respect to: means of ignition; maximum compression ratio; regulating air or mixture supply to the cylinder; pollution from the exhaust.
Fuel
Types, grades, characteristics, limitations
Name the type of fuel used for petrol engines including its colour (AVGAS); 100 (green); 100LL (blue).
Name the type of fuel normally used for aviation diesel engines (JET-A1).
Define the term ‘octane rating’.
Define the term ‘detonation’ and describe the causes and effects of detonation for both petrol and diesel engines.
Define the term ‘pre-ignition’ and describe the causes and effects of pre-ignition for both petrol and diesel engines.
Identify the conditions and power settings that promote detonation for petrol engines.
Describe how detonation in petrol engines is recognised.
Describe the method and occasions for checking the fuel for water content.
State the typical value of fuel density for aviation gasoline and diesel fuel.
Explain volatility, viscosity and vapour locking for petrol and diesel fuels.

Engine fuel pumps

Engine-driven fuel pump

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

Carburettor/injection system

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

State the purpose of a carburettor.
Describe the operating principle of the simple float chamber carburettor.
Describe the methods of obtaining mixture control over the whole operating engine power setting range (compensation jet, diffuser).
Describe the methods of obtaining mixture control over the whole operating altitude range.
Explain the purpose and the operating principle of an accelerator pump.
Explain the purpose of power enrichment.
Describe the function of the carburettor heat system.
Explain the effect of carburettor heat on mixture ratio and power output.
Explain the purpose and the operating principle of a primer pump.
Discuss other methods for priming an engine (acceleration pumps).
Explain the danger of carburettor fire, including corrective measures.

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

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

Icing

Describe the causes and effects of carburettor icing and the action to be taken if carburettor icing is suspected.
Name the meteorological conditions under which carburettor icing may occur.
Describe the indications of the presence of carburettor icing for both a fixed pitch and a constant speed propeller.
Describe the indications that will occur upon selection of carburettor heat depending on whether ice is present or not.
Explain the reason for the use of alternate air on fuel injection systems and describe its operating principle.
State the meteorological conditions under which induction system icing may occur.

Cooling systems

Design, operation, indications and warnings

Specify the reasons for cooling a piston engine.
Describe the design features to enhance cylinder air cooling for aeroplanes.
Compare the differences between liquid- and air-cooling systems.
Identify the cylinder head temperature indication to monitor engine cooling.
Describe the function and the operation of cowl flaps.

Lubrication systems

Lubricants: characteristics, limitations

Describe the term 'viscosity' including the effect of temperature.
Describe the viscosity grade numbering system used in aviation.

Design, operation, indications and warnings

State the functions of a piston-engine lubrication system.
Describe the working principle of a dry-sump lubrication system and describe the functions of the following components: oil tank (reservoir) and its internal components: hot well, de-aerator, vent, expansion space; check valve (non-return valve); pressure pump and pressure-relief valve; scavenge pump; filters (suction, pressure and scavenge); oil cooler; oil cooler bypass valve (anti-surge and thermostatic); pressure and temperature sensors; lines.
Describe a wet-sump lubrication system.
State the differences between a wet- and a dry-sump lubrication system and their advantages and disadvantages.
List the following factors that influence oil consumption: oil grade; cylinder and piston wear; condition of piston rings.
Describe the interaction between oil pressure, oil temperature and oil quantity.

Ignition circuits

Design, operation

Describe the working principle of a magneto-ignition system and the functions of the following components: magneto; contact-breaker points; capacitor (condenser); coils or windings; ignition switches; distributor; spark plug; high-tension (HT) cable.
State why piston engines are equipped with two electrically independent ignition systems.
State the function and operating principle of the following methods of spark augmentation: starter vibrator (booster coil); impulse-start coupling.
State the function and operating principle of the following methods of spark augmentation: starter vibrator (booster coil); both magnetos live.

Explain the function of the magneto check.
Explain how combustion is initiated in diesel engines.

Mixture

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

Define the following terms: mixture; chemically correct ratio (stoichiometric); best power ratio; lean (weak) mixture (lean or rich side of the exhaust gas temperature (EGT) top); rich mixture.
State the typical fuel-to-air ratio values or range of values for the above mixtures.
Describe the advantages and disadvantages of weak and rich mixtures.
Describe the relation between engine-specific fuel consumption and mixture ratio.
Describe the use of the exhaust gas temperature as an aid to mixture-setting.
Explain the relation between mixture ratio, cylinder head temperature, detonation and pre-ignition.
Explain the absence of mixture control in diesel engines.

Aeroplane: propellers

Definitions, general

Remark: Definitions and aerodynamic concepts are detailed in subject 081, topic 07 (Propellers) but need to be appreciated for this subject also.

Constant-speed propeller: design, operation, system components

Describe the operating principle of a constant-speed propeller system under normal flight operations with the aid of a schematic.
Explain the need for a MAP indicator to control the power setting with a constant-speed propeller.
State the purpose of a torque-meter.
State the purpose and describe the operation of a low-pitch stop (centrifugal latch).
Describe the operating principle of a single-acting and a double-acting variable pitch propeller for single- and multi-engine aeroplanes.
Describe the function and the basic operating principle of synchronising and synchro-phasing systems.
Explain the purpose and the basic operating principle of an auto-feathering system and unfeathering.

Reduction gearing: design

State the purpose of reduction gearing.

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

Describe the checks to be carried out on a constant-speed propeller system after engine start.
Describe the operation of a constant-speed propeller system during flight at different true airspeeds (TAS) and rpm including an overspeeding propeller.
Describe the operating principle of a variable pitch propeller when feathering and unfeathering, including the operation of cockpit controls.
Describe the operating principle of a variable pitch propeller when reverse pitch is selected, including the operation of cockpit controls.
Describe the operation of the propeller levers during different phases of flight.

Performance and engine handling

Performance

Describe the effect on power output of a petrol and diesel engine taking into consideration the following parameters: ambient pressure, exhaust back pressure; temperature; density altitude; humidity.
Explain the term 'normally aspirated engine'.
Power-augmentation devices: explain the requirement for power augmentation (turbocharging) of a piston engine.
Describe the function and the principle of operation of the following main components of a turbocharger: turbine; compressor; waste gate; waste-gate actuator.
Explain the difference between an altitude-boosted turbocharger and a ground-boosted turbocharger.
Explain turbo lag.
Define the term 'critical altitude'.
Explain the function of an intercooler.
Define the terms 'full-throttle height' and 'rated altitude'.
Explain the purpose of a supercharger and the basic differences from a turbocharger.

Engine handling

State the correct procedures for setting the engine controls when increasing or decreasing power.
Define the following terms: take-off power; maximum continuous power.
Describe the start problems associated with extreme cold weather.
Describe the principal difference between a full-authority digital engine control (FADEC) system-controlled engine and traditional manual engine controls.
Describe the engine controls available on the flight deck for a FADEC-controlled engine.
Explain that the FADEC has full authority of the control of all engine parameters ensuring efficient and correct running of the engine, including protection in the event of failure.

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

TURNINE ENGINES

Basic principles

Basic generation of thrust and the thrust formula

Describe how thrust is produced by a basic gas turbine engine.
Describe the simple form of the thrust formula for a basic, straight jet engine and perform simple calculations (including pressure thrust).
State that thrust can be considered to remain approximately constant over the whole aeroplane subsonic speed range.

Design, types and components of turbine engines

List the main components of a basic gas turbine engine: inlet; compressor; combustion chamber; turbine; outlet.
Describe the variation of static pressure, temperature and axial velocity in a gas turbine engine under normal operating conditions and with the aid of a working cycle diagram.
Describe the differences between absolute, circumferential (tangential) and axial velocity.
List the different types of gas turbine engines: straight jet; turbofan; turboprop.
State that a gas turbine engine can have one or more spools.
Describe how thrust is produced by turbojet and turbofan engines.
Describe how power is produced by turboprop engines.
Describe the term 'equivalent horsepower' (= thrust horsepower + shaft horsepower).
Explain the principle of a free turbine or free-power turbine.
Define the term 'bypass ratio' and perform simple calculations to determine it.
Define the terms 'propulsive power', 'propulsive efficiency', 'thermal efficiency' and 'total efficiency'.
Describe the influence of compressor-pressure ratio on thermal efficiency.
Explain the variations of propulsive efficiency with forward speed for turbojet, turbofan and turboprop engines.
Define the term 'specific fuel consumption' for turbojets and turboprops.

Coupled turbine engine: design, operation, components and materials

Name the main assembly parts of a coupled turbine engine and explain its operation.
Explain the limitations of the materials used with regard to maximum turbine temperature, engine and drive train torque limits.
Describe the possible effects on engine components when limits are exceeded.
Explain that when engine limits are exceeded, this event must be reported.

Free-turbine engine: design, components and materials

List the main components of a free-turbine engine.
Describe how the power is developed by a turboshaft/free-turbine engine.
Explain how the exhaust gas temperature is used to monitor turbine stress.

Main-engine components

Aeroplane: air intake

State the functions of the engine air inlet/air intake.
Describe the geometry of a subsonic (pitot-type) air inlet.
Explain the gas-parameter changes in a subsonic air inlet at different flight speeds.
Describe the reasons for, and the dangers of, the following operational problems concerning the engine air inlet: airflow separation; inlet icing; inlet damage; foreign object damage (FOD); heavy in-flight turbulence.

Compressor and diffuser

State the purpose of the compressor.
Describe the working principle of a centrifugal and an axial flow compressor.
Name the following main components of a single stage and describe their function for a centrifugal compressor: impeller; diffuser.
Name the following main components of a single stage and describe their function for an axial compressor: rotor vanes; stator vanes.
Describe the gas-parameter changes in a compressor stage.
Define the term 'pressure ratio' and state a typical value for one stage of a centrifugal and an axial flow compressor and for the complete compressor.
State the advantages and disadvantages of increasing the number of stages in a centrifugal compressor.
Explain the difference in sensitivity for FOD of a centrifugal compressor compared with an axial flow type.
Explain the convergent air annulus through an axial flow compressor.
Describe the reason for twisting the compressor blades.
State the tasks of inlet guide vanes (IGVs).
State the reason for the clicking noise whilst the compressor slowly rotates on the ground.
State the advantages of increasing the number of spools.
Explain the implications of tip losses and describe the design features to minimise the problem.

Explain the problems of blade bending and flapping and describe the design features to minimise the problem.
Explain the following terms: compressor stall; engine surge.
State the conditions that are possible causes of stall and surge.
Describe the indications of stall and surge.
Describe the design features used to minimise the occurrence of stall and surge.
Describe a compressor map (surge envelope) with rpm lines, stall limit, steady state line and acceleration line.
Describe the function of the diffuser.

Combustion chamber

Define the purpose of the combustion chamber.
List the requirements for combustion.
Describe the working principle of a combustion chamber.
Explain the reason for reducing the airflow axial velocity at the combustion chamber inlet (snout).
State the function of the swirl vanes (swirler).
State the function of the drain valves.
Define the terms 'primary airflow' and 'secondary airflow', and explain their purpose.
Explain the following two mixture ratios: primary airflow to fuel; total airflow (within the combustion chamber) to fuel.
Describe the gas-parameter changes in the combustion chamber.
State a typical maximum value of the outlet temperature of the combustion chamber.
Describe the following types of combustion chambers and state the differences between them: can type; can-annular, cannular or turbo-annular; annular; reverse-flow annular.

Turbine

Explain the purpose of a turbine in different types of gas turbine engines.
Describe the principles of operation of impulse, reaction and impulse-reaction axial flow turbines.
Name the main components of a turbine stage and their function.
Describe the working principle of a turbine.
Describe the gas-parameter changes in a turbine stage.
Describe the function and the working principle of active clearance control.
Describe the implications of tip losses and the means to minimise them.
Explain why the available engine thrust is limited by the turbine inlet temperature.
Explain the divergent gas-flow annulus through an axial-flow turbine.
Explain the high mechanical thermal stress in the turbine blades and wheels/discs.

Aeroplane: exhaust

Name the following main components of the exhaust unit and their function: jet pipe; propelling nozzle; exhaust cone.
Describe the working principle of the exhaust unit.
Describe the gas-parameter changes in the exhaust unit.
Define the term 'choked exhaust nozzle' (not applicable to turboprops).
Explain how jet exhaust noise can be reduced.

Additional components and systems

Engine fuel system

Name the main components of the engine fuel system and state their function: filters; low-pressure (LP) pump; high-pressure (HP) pump; fuel manifold; fuel nozzles; HP fuel cock; fuel control; or hydromechanical unit.
Name the two types of engine-driven high-pressure pumps, such as: gear-type; swash plate-type.
State the tasks of the fuel control unit.
List the possible input parameters to a fuel control unit to achieve a given thrust/power setting.

Engine control system

State the tasks of the engine control system.
List the following different types of engine control systems: hydromechanical; hydromechanical with a limited authority electronic supervisor; single-channel FADEC with hydromechanical backup; dual-channel FADEC with no backup or any other combination.
Describe a FADEC as a full-authority dual-channel system including functions such as an electronic engine control unit, wiring, sensors, variable vanes, active clearance control, bleed configuration, electrical signalling of thrust lever angle (TLA) (see also AMC to CS-E-50), and an EGT protection function and engine overspeed.
Explain how redundancy is achieved by using more than one channel in a FADEC system.
State the consequences of a FADEC single input data failure.
State that all input and output data is checked by both channels in a FADEC system.
State that a FADEC system uses its own sensors and that, in some cases, also data from aircraft systems is used.
State that a FADEC must have its own source of electrical power.

Engine lubrication
State the tasks of an engine lubrication system.
Name the following main components of a lubrication system and state their function: oil tank and centrifugal breather; oil pumps (pressure and scavenge pumps); oil filters (including the bypass); oil sumps; chip detectors; coolers.
Explain that each spool is fitted with at least one ball bearing and two or more roller bearings.
Explain the use of compressor air in oil-sealing systems (e.g. labyrinth seals).
Engine auxiliary gearbox
State the tasks of the auxiliary gearbox.
Describe how the gearbox is driven and lubricated.
Engine ignition
State the task of the ignition system.
Name the following main components of the ignition system and state their function: power sources; igniters.
State why jet turbine engines are equipped with two electrically independent ignition systems.
Explain the different modes of operation of the ignition system.
Engine starter
Name the main components of the starting system and state their function.
Explain the principle of a turbine engine start.
Describe the following two types of starters: electric; pneumatic.
Describe a typical start sequence (on ground/in flight) for a turbofan.
Define 'self-sustaining rpm'.
Reverse thrust
Name the following main components of a reverse-thrust system and state their function: reverse-thrust select lever; power source (pneumatic or hydraulic); actuators; doors; annunciations.
Explain the principle of a reverse-thrust system.
Identify the advantages and disadvantages of using reverse thrust.
Describe and explain the following different types of thrust-reverser systems: hot-stream reverser; clamshell or bucket-door system; cold-stream reverser (only turbofan engines); blocker doors; cascade vanes.
Explain the implications of reversing the cold stream (fan reverser) only on a high bypass ratio engine.
Describe the protection features against inadvertent thrust-reverse deployment in flight as present on most transport aeroplanes.
Describe the controls and indications provided for the thrust-reverser system.
Engine operation and monitoring
General
Explain the following aeroplane engine ratings: take-off; go-around; maximum continuous thrust/power; maximum climb thrust/power.
Explain spool-up time.
Explain the reason for the difference between ground and approach flight idle values (rpm).
State the parameters that can be used for setting and monitoring the thrust/power.
Describe the terms 'alpha range', 'beta range' and 'reverse thrust' as applied to a turboprop power lever.
Explain the dangers of inadvertent beta-range selection in flight for a turboprop.
Explain the purpose of engine trending.
Explain how the exhaust gas temperature is used to monitor turbine stress.
Describe the effect of engine acceleration and deceleration on the EGT.
Describe the possible effects on engine components when EGT limits are exceeded.
Explain why engine-limit exceedances must be reported.
Explain the limitations on the use of the thrust-reverser system at low forward speed.
Explain the term 'engine seizure'.
State the possible causes of engine seizure and explain their preventative measures.
Describe the potential consequences of a leak in the following two designs of fuel and oil heat exchanger: oil pressure higher than fuel pressure with oil leaking into the fuel system, potentially affecting the combustion and running of the engine; fuel pressure higher than oil pressure with fuel leaking into the oil system, potentially increasing the risk of a fire due to fuel entering warm parts of the engine that should be free from fuel.
Explain oil-filter clogging (blockage) and the implications for the lubrication system.
Give examples of monitoring instruments of an engine.
Describe how to identify and assess engine damage based on instrument indications.
Starting malfunctions
Describe the indications and the possible causes of the following aeroplane starting malfunctions: false (dry or wet) start; tailpipe fire (torching); hot start; abortive (hung) start; no N1 rotation; no FADEC indications.

Relight envelope
Explain the relight envelope.
Performance aspects
Thrust, performance aspects, and limitations
Describe the variation of thrust and specific fuel consumption with altitude at constant TAS.
Describe the variation of thrust and specific fuel consumption with TAS at constant altitude.
Explain the term 'flat-rated engine' by describing the change of take-off thrust, turbine inlet temperature and engine rpm with outside air temperature (OAT).
Define the term 'engine pressure ratio' (EPR).
Explain the use of reduced (flexible) and derated thrust for take-off, and explain the advantages and disadvantages when compared with a full-rated take-off.
Describe the effects of use of bleed air on rpm, EGT, thrust, and specific fuel consumption.
Auxiliary power unit (APU)
Design, operation, functions, operational limitations
State that an APU is a gas turbine engine and list its tasks.
State the difference between the two types of APU inlets.
Define 'maximum operating and maximum starting altitude'.
Name the typical APU control and monitoring instruments.
Describe the APU's automatic shutdown protection.
PROTECTION AND DETECTION SYSTEMS
Smoke detection
Types, design, operation, indications and warnings
Explain the operating principle of the following types of smoke detection sensors: optical; ionising.
Give an example of warnings, indications and function tests.
Fire-protection systems
Fire extinguishing (engine and cargo compartments)
Explain the operating principle of a built-in fire-extinguishing system and describe its components.
State that two discharges must be provided for each engine (see CS 25.1195(c) Fire-extinguisher systems).
Fire detection
Explain the following principles of fire detection: resistance and capacitance; gas pressure.
Explain fire-detection applications such as: bimetallic; continuous loop; gaseous loop (gas-filled detectors).
Explain why generally double-loop systems are used.
Give an example of warnings, indications and function tests of a fire-protection system.
Rain-protection system
Principle and method of operation
Explain the principle and method of operation of the following windshield rain-protection systems for an aeroplane: wipers; liquids (rain-repellent); coating.
OXYGEN SYSTEMS
Cockpit, portable and chemical oxygen systems
Operating principles, actuation methods, comparison
Describe the basic operating principle of a cockpit oxygen system and describe the following different modes of operation: normal (diluter demand); 100 %; emergency.
Describe the operating principle and the purposes of the following two portable oxygen systems: smoke hood; portable bottle.
Describe the following two oxygen systems that can be used to supply oxygen to passengers: fixed system (chemical oxygen generator or gaseous system); portable.
Describe the actuation methods (automatic and manual) and the functioning of a passenger oxygen mask.
Compare chemical oxygen generators to gaseous systems with respect to: capacity; flow regulation.
State the dangers of grease or oil related to the use of oxygen systems.

022. AIRCRAFT GENERAL KNOWLEDGE - INSTRUMENTATION

SENSORS AND INSTRUMENTS
Pressure gauge
Units for pressure, sensor types, measurements
Define 'pressure', 'absolute pressure' and 'differential pressure'.
List the following units used for pressure measurement: Pascal; bar; inches of mercury (in Hg); pounds per square inch (psi).
State the relationship between the different units.

List and describe the following different types of sensors used according to the pressure to be measured: aneroid capsules; bellows; diaphragms; bourdon tube.
Identify pressure measurements that are applicable to an aircraft: liquid-pressure measurement (fuel, oil, hydraulic); air-pressure measurement (bleed-air systems, air-conditioning systems); engine-pressure measurement manifold pressure (MAP), engine pressure ratio (EPR)).
Identify and read pressure measurement indications both for engine indications and other systems.
Explain the implications of the following pressure measurement errors both for engine indications and other systems: loss of pressure sensing; incorrect pressure indications.

Temperature sensing

Units for temperature, measurements

Explain temperature.
List the following units that can be used for temperature measurement: Kelvin; Celsius; Fahrenheit.
State the relationship between these units and convert between them.
Identify temperature measurements that are applicable to an aircraft: gas temperature measurement (ambient air, bleed-air systems, air-conditioning systems, air inlet, exhaust gas, gas turbine outlets); liquid-temperature measurement (fuel, oil, hydraulic); component-temperature measurement (generator, transformer rectifier unit (TRU), pumps (fuel, hydraulic), power transfer unit (PTU).
Identify and read temperature measurement indications for both engine indications and other systems.

Fuel gauge

Units for fuel, measurements, fuel gauges

State that the quantity of fuel can be measured by volume or mass.
List the following units used for fuel quantity: kilogramme; pound; litres; gallons (US and imperial).
Convert between the various units.
Explain the parameters that can affect the measurement of the volume or mass of the fuel in a fuel tank: temperature; aircraft accelerations and attitudes; and explain how the fuel-gauge system design compensates for these changes.
Describe and explain the operating principles of the following types of fuel gauges: float system; capacitance-type of fuel-gauge system.ultrasound-type of fuel-gauge system: to be introduced at a later date.
Describe and complete a typical post-refuelling procedure for a pilot: recording the volume that was filled; converting to the appropriate unit used by the aircraft fuel gauge(s) to compare the actual indicated fuel content to the calculated fuel content; assess appropriate action if the numbers does not compare.

Fuel flowmeters

Fuel flow, units for fuel flow, total fuel consumption

Define 'fuel flow' and where it is measured.
State that fuel flow may be measured by volume or mass per unit of time.
List the following units used for fuel flow when measured by mass per hour: kilogrammes/hour; pounds/hour.
List the following units used for fuel flow when measured by volume per hour: litres/hour; imperial gallons/hour; US gallons/hour.
Explain how total fuel consumption is obtained.

Tachometer

Types, operating principles, units for engine speed

List the following types of tachometers, describe their basic operating principle and give examples of use: mechanical (rotating magnet); electrical (three-phase tacho-generator); electronic (impulse measurement with speed probe and phonic wheel); and describe the operating principle of each type.
Explain the typical units for engine speed: rpm for piston-engine aircraft; - percentage for turbine-engine aircraft.
Explain that some types of rpm indicators require electrical power to provide an indication.

Thrust measurement

Parameters, operating principle

List and describe the following two parameters used to represent thrust: N1; - EPR.
Explain the operating principle of using an engine with EPR indication and explain the consequences of incorrect or missing EPR to the operation of the engine, including reverting to N1 mode.
Give examples of display for N1 and EPR.

Engine torquemeter

Torque, torquemeters

Define 'torque'.
Explain the relationship between power, torque and rpm.
List the following units used for torque: Newton meters; inch or foot pounds.
State that engine torque can be displayed as a percentage.
List and describe the following different types of torquemeters, and explain their operating principles: mechanical; electronic.

Compare the two systems with regard to design and weight.
Give examples of display.
Synchroscope
Purpose, operating principle, display
State the purpose of a synchroscope.
Explain the operating principle of a synchroscope.
Give examples of display.
Engine-vibration monitoring
Purpose, operating principle of a vibration-monitoring system, display
State the purpose of a vibration-monitoring system for a jet engine.
Describe the operating principle of a vibration-monitoring system using the following two types of sensors: piezoelectric crystal; magnet.
Explain that there is no specific unit for vibration monitoring, i.e. it is determined by specified numeric threshold values.
Give examples of display.
Time measurement
On-board clock
Explain that the on-board aircraft clock provides a time reference for several of the on-board systems including aircraft communications addressing and reporting system (ACARS) and engine and systems maintenance.
MEASUREMENT OF AIR-DATA PARAMETERS
Pressure measurement
Definitions
Define the following pressure measurements and state the relationship between them: static pressure; dynamic pressure; - total pressure.
Pitot/static system: design and errors
Describe the design and the operating principle of a: static port/source; pitot tube; combined pitot/static probe. For each of these indicate the various locations and describe the following associated errors and how to correct, minimise the effect of or compensate for them: position errors; instrument errors; errors due to a non-longitudinal axial flow (including manoeuvre-induced errors).
Describe a typical pitot/static system and list the possible outputs.
Explain the redundancy and the interconnections that typically exist in complex pitot/static systems found in large aircraft.
Explain the purpose of pitot/static system heating.
Describe alternate static sources and their effects when used, particularly in unpressurised aircraft.
Describe a modern pitot static system using solid-state sensors near the pitot probe or static port converting the air data to numerical data (electrical signals) before being sent to the air-data computer(s).
Temperature measurement
Definitions
Define the following and explain the relationship between them: outside air temperature (OAT); total air temperature (TAT); - static air temperature (SAT).
Explain the term 'ram rise' and convert TAT to SAT.
Explain why TAT is often displayed and that TAT is the temperature input to the air-data computer.
Design and operation
Indicate typical locations for both direct-reading and remote-reading temperature probes, and describe the following errors: position error; - instrument error.
Explain the purpose ~~of temperature probe~~ heating and interpret the effect of heating on sensed temperature unless automatically compensated for.
Angle-of-attack (AoA) measurement
Sensor types, operating principles, ice protection, displays, incorrect indications
Describe the following two types of AoA sensors: null-seeking (slotted) probe; vane detector.
For each type, explain the operating principles.
Explain how both types are protected against ice.
Give examples of systems that use the AoA as an input, such as: air-data computer; stall warning systems; flight-envelope protection systems.
Give examples of and interpret different types of AoA displays: simple light arrays of green, amber and red lights; - gauges showing a numerical scale.
Explain the implications for the pilot if the AoA indication becomes incorrect but still provides data, e.g. if the sensor is frozen in a fixed position.
Explain how an incorrect AoA measurement can affect the controllability of an aircraft with flight-envelope protection.

Altimeter

Units, terms, types, operating principles, displays, errors, corrections

List the following two units used for altimeters and state the relationship between them: feet; metres.

Define the following terms: height, altitude; indicated altitude, true altitude; pressure altitude, density altitude.

Define the following barometric references: 'QNH', 'QFE', '1013,25'.

Explain the operating principles of an altimeter.

Describe and compare the following three types of altimeters and reason(s) why particular designs may be required in certain airspace: simple altimeter (single capsule); sensitive altimeter (multi-capsule); servo-assisted altimeter.

Give examples of associated displays: pointer, multi-pointer, drum, vertical straight scale.

Describe the following errors: static system error; instrument error; barometric error; temperature error (air column not at ISA conditions); lag (altimeter response to change of height).

Demonstrate the use of an altimeter correction table for the following errors: temperature corrections; - aircraft position errors.

Describe the effects of a blockage or a leakage on the static pressure line.

Describe the use of GPS altitude as an alternative means of checking erroneous altimeter indications, and highlight the limitations of the GPS altitude indication.

Vertical speed indicator (VSI)

VSI and instantaneous vertical speed indicator (IVSI)

List the two units used for VSIs and state the relationship between them: metres per second; feet per minute.

Explain the operating principles of a VSI and an IVSI.

Describe and compare the following types of VSIs: barometric type (VSI); instantaneous barometric type (IVSI); inertial type (inertial information provided by an inertial reference unit).

Describe the following VSI errors: static system errors; instrument errors; time lag.

Describe the effects on a VSI of a blockage or a leakage on the static pressure line.

Give examples of a VSI display.

Compare the indications of a VSI and an IVSI during flight in turbulence and appropriate pilot technique during manoeuvring using either type.

Airspeed indicator (ASI)

Units, errors, operating principles, displays, position errors, unreliable airspeed indications

List the following three units used for airspeed and state the relationship between them: nautical miles/hour (kt); statute miles/hour (mph); kilometres/hour (km/h).

Describe the following ASI errors and state when they must be considered: pitot/static system errors; instrument errors; position errors; compressibility errors; density errors.

Explain the operating principles of an ASI (as appropriate to aeroplanes or helicopters).

Give examples of an ASI display: pointer, vertical straight scale, and digital (HUD display).

Demonstrate the use of an ASI correction table for position error.

Define and explain the following colour codes that can be used on an ASI: white arc (flap operating speed range); green arc (normal operating speed range); yellow arc (caution speed range); red line (VNE) or barber's pole (VMO); blue line (best rate of climb speed, one-engine-out for multi-engine piston light aeroplanes).

Define and explain the following colour codes that can be used on an ASI: green arc (normal operating speed range); red line (VNE); - blue line (maximum airspeed during autorotation).

Describe the effects on an ASI of a blockage or a leakage in the static or total pressure line(s).

Define the term 'unreliable airspeed' and describe the means by which it can be recognised such as: different airspeed indications between ASIs; unexpected aircraft behaviour; buffeting; aircraft systems warning; aircraft attitude.

Describe the appropriate procedures available to the pilot in the event of unreliable airspeed indications: combination of a pitch attitude and power setting; ambient wind noise inside the aircraft; use of GPS speed indications and the associated limitations.

Machmeter

Operating principle, display, CAS, TAS and Mach number

Define 'Mach number' and 'local speed sound' (LSS). Calculate between LSS, TAS and Mach number.

Describe the operating principle of a Machmeter.

Explain why a Machmeter does not suffer from compressibility error.

Give examples of a Machmeter display: pointer, drum, vertical straight scale, digital.

Describe the effects on a Machmeter of a blockage or a leakage in the static or total pressure line(s).

Explain the relationship between CAS, TAS and Mach number. Explain how CAS, TAS and Mach number vary in relation to each other during a climb, a descent, or in level flight in different temperature conditions.

State the existence of maximum operating limit speed (VMO) and maximum operating Mach number (MMO).

Describe typical indications of MMO and VMO on analogue and digital instruments.

Describe the relationship between MMO and VMO with change in altitude and the implications of climbing at constant IAS and descending at constant Mach number with respect to the margin to MMO and VMO.
Describe the implications of climbing or descending at constant Mach number or constant IAS with respect to the margin to the stall speed or maximum speed.

Air-data computer (ADC)

Operating principle, data, errors, air-data inertial reference unit

Explain the operating principle of an ADC.
List the following possible input data: TAT; static pressure; total pressure; measured temperature; AoA; flaps position; landing gear position; stored aircraft data.
List the following possible output data, as applicable to aeroplanes or helicopters: IAS; TAS; SAT; TAT; Mach number; AoA; altitude; vertical speed; VMO/MMO pointer.
Explain how position, instrument, compressibility and density errors can be compensated/corrected to achieve a TAS calculation.
Give examples of instruments or systems which may use ADC output data.
Explain that an air-data inertial reference unit (ADIRU) is an ADC integrated with an inertial reference unit (IRU), that there will be separate controls for the ADC part and inertial reference (IR) part, and that incorrect selection during failure scenarios may lead to unintended and potentially irreversible consequences.
Explain the ADC architecture for air-data measurement including sensors, processing units and displays, as opposed to stand-alone air-data measurement instruments.
Describe the consequences of the loss of an ADC compared to the failure of individual instruments.

MAGNETISM - DIRECT-READING COMPASS AND FLUX VALVE

Earth's magnetic field

Magnetic field, variation, dip

Describe the magnetic field of the Earth.
Explain the properties of a magnet.
Define the following terms: magnetic variation; magnetic dip (inclination).
Describe that a magnetic compass will align itself to both the horizontal (azimuth) and vertical (dip) components of the Earth's magnetic field, thus will not function in the vicinity of the magnetic poles.
Demonstrate the use of variation values (given as East/West (E/W) or +/–) to calculate: true heading to magnetic heading; - magnetic heading to true heading.

Aircraft magnetic field

Permanent magnetism, electromagnetism, deviation

Explain the following differences between permanent magnetism and electromagnetism: - when they are present; - what affects their magnitude.
Explain the principles of and the reasons for: compass swinging (determination of initial deviations); compass compensation (correction of deviations found); compass calibration (determination of residual deviations).
Explain how permanent magnetism within the aircraft structure and electromagnetism from the aircraft systems affect the accuracy of a compass.
Describe the purpose and the use of a deviation correction card.
Demonstrate the use of deviation values (either given as E/W or +/–) from a compass deviation card to calculate: compass heading to magnetic heading; - magnetic heading to compass heading.

Direct-reading magnetic compass

Purpose, errors, timed turns, serviceability

Explain the purpose of a direct-reading magnetic compass.
Describe how the direct-reading magnetic compass will only show correct indications during straight, level and unaccelerated flight, and that an error will occur during the following flight manoeuvres (no numerical examples): - acceleration and deceleration; - turning; - during pitch-up or pitch-down manoeuvres.
Explain how the use of timed turns eliminates the problem of the turning errors of a direct-reading magnetic compass, and calculate the duration of a rate-1 turn for a given change of heading.
Describe the serviceability check for a direct-reading magnetic compass prior to flight, such as: the physical appearance of the device; comparing the indication to another known direction such as a different compass or runway direction.

Flux valve

Purpose, operating principle, location, errors

Explain the purpose of a flux valve.
Explain its operating principle.
Indicate typical locations of the flux valve(s).
Give the remote-reading compass system as example of application for a flux valve.
Explain that deviation is compensated for and, therefore, eliminates the need for a deviation correction card.

Explain that a flux valve does not suffer from the same magnitude of errors as a direct-reading magnetic compass when turning, accelerating or decelerating and during pitch-up or pitch-down manoeuvres.

GYROSCOPIC INSTRUMENTS

Gyroscope: basic principles

Gyroscopic forces, degrees of freedom, gyro wander, driving gyroscopes

Define a 'gyro'.

Explain the fundamentals of the theory of gyroscopic forces.

Define the 'degrees of freedom' of a gyro. *Remark: As a convention, the degrees of freedom of a gyroscope do not include its own axis of rotation (the spin axis)*.

Explain the following terms: rigidity; precession; wander (drift/topple).

Explain the three types of gyro wander: real wander; apparent wander; transport wander.

Describe the two ways of driving gyroscopes and any associated indications: air/vacuum; electrically.

Rate-of-turn indicator - Turn co-ordinator - Balance (slip) indicator

Indications, relation between bank angle, rate of turn and TAS

Explain the purpose of a rate-of-turn and balance (slip) indicator.

Define a 'rate-1 turn'.

Describe the indications given by a rate-of-turn indicator.

Explain the relation between bank angle, rate of turn and TAS, and how bank angle becomes the limiting factor at high speed (no calculations).

Explain the purpose of a balance (slip) indicator and its principle of operation.

Explain the purpose of a balance (slip) indicator and its principle of operation.

Describe the indications of a rate-of-turn and balance (slip) indicator during a balanced, slip or skid turn.

Describe the indications given by a turn coordinator (or turn-and-bank indicator).

Compare the indications on the rate-of-turn indicator and the turn coordinator.

Attitude indicator (artificial horizon)

Purpose, types, effect of aircraft acceleration, display

Explain the purpose of the attitude indicator.

Identify the two types of attitude indicators: attitude indicator; attitude and director indicator (ADI).

State the degrees of freedom.

Describe the effects of the aircraft's acceleration and turns on instrument indications.

Describe a typical attitude display and instrument markings.

Directional gyroscope

Purpose, types, drift, alignment to compass heading

Explain the purpose of the directional gyroscope.

Identify the two types of gyro-driven direction indicators: direction indicator; horizontal situation indicator (HSI).

Explain how the directional gyroscope will drift over time due to the following: rotation of the Earth; aircraft manoeuvring; aircraft movement over the Earth's surface/direction of travel.

Describe the procedure for the pilot to align the directional gyroscope to the correct compass heading.

Remote-reading compass systems

Operating principles, components, comparison with a direct-reading magnetic compass

Describe the principles of operation of a remote-reading compass system.

Using a block diagram, list and explain the function of the following components of a remote-reading compass system: flux detection unit; gyro unit; transducers, precession amplifiers, annunciator; display unit (compass card, synchronising and set-heading knob, DG/compass/slave/free switch).

State the advantages and disadvantages of a remote-reading compass system compared to a direct-reading magnetic compass with regard to: design (power source, weight and volume); deviation due to aircraft magnetism; turning and acceleration errors; attitude errors; accuracy and stability of the information displayed; availability of the information for several systems (compass card, RMI, automatic flight control system (AFCS)).

Solid-state systems - attitude and heading reference system (AHRS)

Components, indications

Explain that the AHRS is a replacement for traditional gyros using solid-state technology with no moving parts and is a single unit consisting of: solid-state accelerometers; solid-state rate sensor gyroscopes; solid-state magnetometers (measurement of the Earth's magnetic field).

Explain that the AHRS senses rotation and acceleration for all three axes and senses the direction of the Earth's magnetic field where the indications are normally provided on electronic screens (electronic flight instrument system (EFIS)).

INERTIAL NAVIGATION

Basic principles

Systems

State that inertial navigation/reference systems are the main source of attitude and one of the main sources of navigational data in commercial air transport aeroplanes.
State that inertial systems require no external input, except TAS, to determine aircraft attitude and navigational data.
State that earlier gyro mechanically stabilised platforms are (technically incorrectly but conventionally) referred to as inertial navigation systems (INSs) and more modern fixed (strap down) platforms are conventionally referred to as inertial reference systems (IRSs). INSs can be considered to be stand-alone, whereas IRSs are integrated with the FMS.
Explain the basic principles of inertial navigation
(including double integration of measured acceleration and the necessity for north–south, east–west and vertical components to be measured/extracted).
Explain the necessity of applying correction for transport precession, and Earth rate precession, coriolis and gravity.
State that in modern aircraft fitted with inertial reference system (IRS) and flight management system (FMS), the flight management computer (FMC) position is normally derived from a mathematical analysis of IRS, global positioning system (GPS), and distance measuring equipment (DME) data, VHF omnidirectional radio range (VOR) and LOC.
List all navigational data that can be determined by a stand-alone inertial navigation system.
State that a strap-down system is fixed to the structure of the aircraft and normally consists of three laser ring gyros and three accelerometers.
State the differences between a laser ring gyro and a conventional mechanical gyro.

Alignment and operation

Alignment process, incorrect data entry, and control panels

State that during the alignment process, the inertial platform is levelled (INS) or the local vertical is determined (IRS), and true north/aircraft heading is established.
Explain that the aircraft must be stationary during alignment, the aircraft position is entered during the alignment phase, and that the alignment process takes around 10 to 20 minutes at mid latitudes (longer at high latitudes).
State that in-flight realignment is not possible and loss of alignment leads to loss of navigational data although attitude information may still be available.
Explain that the inertial navigation system (INS) platform is maintained level and north-aligned after alignment is complete and the aircraft is in motion.
State that an incorrect entry of latitude may lead to a loss of alignment and is more critical than the incorrect entry of longitude.
State that the positional error of a stand-alone INS varies (a typical value can be quoted as 1–2 NM/h) and is dependent on the gyro drift rate, accelerometer bias, misalignment of the platform, and computational errors.
Explain that, on a modern aircraft, there is likely to be an air-data inertial reference unit (ADIRU), which is an inertial reference unit (IRU) integrated with an air-data computer (ADC).
Identify examples of IRS control panels.
Explain the following selections on the IRU mode selector: NAV (normal operation); ATT (attitude only).
State that the majority of the IRS data can be accessed through the FMS control and display unit (CDU)/flight management and guidance system (FMGS) multifunction control and display unit (MCDU).
Describe the procedure available to the pilot for assessing the performance of individual IRUs after a flight: reviewing the residual indicated ground speed when the aircraft has parked; reviewing the drift given as NM/h.

AEROPLANE: AUTOMATIC FLIGHT CONTROL SYSTEMS

General

Definitions and control loops

Describe the following purposes of an automatic flight control system (AFCS): enhancement of flight controls; reduction of pilot workload.
Define and explain the following two functions of an AFCS: aircraft control: stabilise the aircraft around its centre of gravity (CG); aircraft guidance: guidance of the aircraft's flight path.
Describe the following two automatic control principles: closed loop, where a feedback from an action or state is compared to the desired action or state; open loop, where there is no feedback loop.
List the following elements of a closed-loop control system and explain their basic function: input signal; error detector; signal processor providing a measured output signal according to set criteria or laws; control element such as an actuator; feedback signal to error detector for comparison with input signal.
Describe how a closed-loop system may enter a state of self-induced oscillation if the system overcompensates for deviations from the desired state.

Explain how a state of self-induced oscillations may be detected and describe the effects of self-induced oscillations: aircraft controllability; aircraft safety; timely manual intervention as a way of mitigating loss of control; techniques that may be used to maintain positive control of the aircraft.

Autopilot system

Design and operation

Define the three basic control channels.

Define the three different types of autopilots: single or 1 axis (roll); 2 axes (pith and roll); 3 axes (pitch, roll and yaw);

Describe the purpose of the following components of an autopilot system: flight control unit (FCU), mode control panel (MCP) or equivalent; flight mode annunciator (FMA) (see Subject 022 06 04 00); autopilot computer; actuator.

Explain the following lateral modes: heading (HDG)/track (TRK); VOR (VOR)/localiser (LOC); lateral navigation/managed navigation (LNAV or NAV).

Describe the purpose of control laws for pitch and roll modes.

Explain the following vertical modes: vertical speed (V/S); flight path angle (FPA); level change (LVL CHG)/open climb (OP CLB) or open descent (OP DES); speed reference system (SRS); altitude (ALT) hold; vertical navigation (VNAV)/managed climb (CLB) or descent (DES); glideslope (G/S).

Describe how the autopilot uses speed, aircraft configuration or flight phase as a measure for the magnitude of control inputs and how this may affect precision and stability.

Explain the following mixed modes: take-off; go-around; approach (APP).

Describe the two types of autopilot configurations and explain the implications to the pilot for either and when comparing the two principles: flight-deck controls move with the control surface when the autopilot is engaged; flight-deck controls remain static when the autopilot is engaged.

Describe the purpose of the following inputs and outputs for an autopilot system: attitude information; flight path/trajectory information; control surface position information; airspeed information; aircraft configuration information; FCU/MCP selections; FMAs.

Describe the purpose of the synchronisation function when engaging the autopilot and explain why the autopilot should be engaged when the aircraft is in trim.

Define the control wheel steering (CWS) mode as manual manoeuvring of the aircraft through the autopilot computer and autopilot servos/actuators using the control column/control wheel.

Describe the following elements of CWS: CWS as an autopilot mode; flight phases where CWS cannot be used; whether the pilot or the autopilot is controlling the flight path; the availability of flight path/performance protections; potential different feel and control response compared to manual flight.

Describe touch control steering (TCS) and highlight the differences when compared to CWS: autopilot remains engaged but autopilot servos/actuators are disconnected from the control surfaces; manual control of the aircraft as long as TCS button is depressed; autopilot servos/actuators reconnect when TCS button is released and the autopilot returns to previously engaged mode(s).

Explain that only one autopilot may be engaged at any time except for when APP is armed in order to facilitate a fail-operational autoland.

Explain the difference between an armed and an engaged mode: not all modes have an armed state available; a mode will only become armed if certain criteria are met; an armed mode will become engaged (replacing the previously engaged mode, if any) when certain criteria are met.

Describe the sequence of events when a mode is engaged and the different phases: initial phase where attitude is changed to obtain a new trajectory in order to achieve the new parameter; the trajectory will be based on rate of closure which is again based on the difference between the original parameter and the new parameter; capture phase where the aircraft will follow a predefined rate of change of trajectory to achieve the new parameter without overshooting/ undershooting; tracking or hold phase where the aircraft will maintain the set parameter until a new change has been initiated.

Explain automatic mode reversion and typical situations where it may occur: no suitable data for the current mode such as flight plan discontinuity when in LNAV/managed NAV; change of parameter during capture phase for original parameter such as change of altitude target during ALT ACQ/ALT*; mismanagement of a mode resulting in engagement of the autopilot envelope protection, e.g. selecting excessive V/S resulting in a loss of speed control.

Explain the dangers of mismanagement of the following modes: use of V/S and lack of speed protection, i.e. excessive V/S or FPA may be selected with subsequent uncontrolled loss or gain of airspeed; arming VOR/LOC or APP outside the protected area of the localiser or ILS.

Describe how failure of other systems may influence the availability of the autopilot and how incorrect data from other systems may result in an undesirable aircraft state, potentially without any failure indications. Explain the importance of prompt and appropriate pilot intervention during such events.

Explain an appropriate procedure for disengaging the autopilot and why both aural and visual warnings are used to indicate that the autopilot is being disengaged: temporary warning for intended disengagement using the design method; continuous warning for unintended disengagement or using a method other than the design method.
Explain the following regarding autopilot and aircraft with manual trim: the autopilot may not engage unless the aircraft controls are in trim; the aircraft will normally be in trim when the autopilot is disconnected; use of manual trim when the autopilot is engaged will normally lead to autopilot disconnection and a risk of an out-of-trim situation.

Flight director: design and operation

Purpose, use, indications, modes, data

Explain the purpose of a flight director system.
Describe the different types of display: pitch and roll crossbars; V-bar.
Explain the differences between a flight director and an
autopilot and how the flight director provides a means of cross-checking the control/guidance commands sent to the autopilot.
Explain why the flight director must be followed when engaged/shown, and describe the appropriate use of the flight director: flight director only; autopilot only; flight director and autopilot; typical job-share between pilots (pilot flying (PF)/pilot monitoring (PM)) for selecting the parameters when autopilot is engaged versus disengaged; highlight when the flight director should not be followed or should be disengaged..
Give examples of different scenarios and the resulting flight director indications.
Explain that the flight director computes and indicates the direction and magnitude of control inputs required in order to achieve an attitude to follow a trajectory.
Explain how the modes available for the flight director are the same as those available for the autopilot, and that the same panel (FCU/MCP) is normally used for selection.
Explain the importance of checking the FMC data or selected autopilot modes through the FMA when using the flight directors. If the flight directors are showing incorrect guidance, they should not be followed and should be turned off.

Aeroplane: flight mode annunciator (FMA)

Purpose, modes, display scenarios

Explain the purpose of FMAs and their importance being the only indication of the state of a system rather than a switch position.
Describe where the FMAs are normally shown and how the FMAs will be divided into sections (as applicable to aircraft complexity): vertical modes; lateral modes; autothrust modes; autopilot and flight director annunciators; landing capability.
Explain why FMAs for engaged or armed modes have different colour or different font size.
Describe the following FMA display scenarios: engagement of a mode; mode change from armed to becoming engaged; mode reversion.
Explain the importance of monitoring the FMAs and announcing mode changes at all times (including when selecting a new mode) and why only certain mode changes will be accompanied by an aural notification or additional visual cues.
Describe the consequences of not understanding what the FMAs imply or missing mode changes, and how it may lead to an undesirable aircraft state.

Autoland

Design and operation

Explain the purpose of an autoland system.
Explain the significance of the following components required for an autoland: autopilot; autothrust; radio altimeter; ILS receivers.
Explain the following terms ~~(reference to CS-AWO 'All Weather Operations'):~~ fail-passive automatic landing system; fail-operational automatic landing system; fail-operational hybrid landing system; alert height.
Describe the autoland sequence including the following: FMAs regarding the landing capability of the aircraft; the significance of monitoring the FMAs to ensure the automatic arming/engagement of modes triggered by defined radio altitudes or other thresholds; in the event of a go-around, that the aircraft performs the go-around manoeuvre both by reading the FMAs and supporting those readings by raw data; during the landing phase, that 'FLARE' mode engages at the appropriate radio altitude, including typical time frame and actions if 'FLARE' does not engage; after landing, that 'ROLL-OUT' mode engages and the significance of disconnecting the autopilot prior to vacating the runway.
Explain that there are operational limitations in order to legally perform an autoland beyond the technical capability of the aircraft.
Explain the purpose and significance of alert height, describe the indications and implications, and consider typical pilot actions for a failure situation: above the alert height; below the alert height.

Describe typical failures that, if occurring below the alert height, will trigger a warning: all autopilots disengage; loss of ILS signal or components thereof; excessive ILS deviations; radio-altimeter failure.
Describe how the failure of various systems, including systems not directly involved in the autoland process, can influence the ability to perform an autoland or affect the minima down to which the approach may be conducted.
Describe the fail-operational hybrid landing system as a primary fail-passive automatic landing system with a secondary independent guidance system such as a head-up display (HUD) to enable the pilot to complete a manual landing if the primary system fails.

TRIMS - YAW DAMPER - FLIGHT-ENVELOPE PROTECTION

Trim systems

Design and operation

Explain the purpose of the trim system and describe the layout with one trim system for each control axis, depending on the complexity of the aircraft.
Give examples of trim indicators and their function, and explain the significance of a 'green band/area' for the pitch trim.
Describe and explain an automatic pitch-trim system for a conventional aeroplane.
Describe and explain an automatic pitch-trim system for an FBW aeroplane and that it is also operating during manual flight; however, during certain phases it may be automatically disabled to alter the handling characteristics of the aircraft.
Describe the consequences of manual operation on the trim wheel when the automatic pitch-trim system is engaged.
Describe and explain the engagement and disengagement conditions of the autopilot according to trim controls.
Define 'Mach trim' and state that the Mach-trim system can be independent.
Describe the implications for the pilot in the event of a runaway trim or significant out-of-trim state.

Yaw damper

Design and operation

Explain the purpose of the yaw-damper system.
Explain the purpose of the Dutch-roll filter (filtering of the yaw input signal).
Explain the operation of a yaw-damper system and state the difference between a yaw-damper system and a 3-axis autopilot operation on the rudder channel.

Flight-envelope protection (FEP)

Purpose, input parameters, functions

Explain the purpose of the FEP.
Explain typical input parameters to the FEP: AoA; aircraft configuration; airspeed information.
Explain the following functions of the FEP: stall protection; overspeed protection.
Explain how the stall-protection function and the overspeed-protection function apply to both mechanical/conventional and FBW control systems, but other functions (e.g. pitch or bank limitation) can only apply to FBW control systems.

AUTOTHRUST - AUTOMATIC THRUST CONTROL SYSTEM

Autothrust system

Purpose, operation, overcompensation, speed control

Describe the purpose of the autothrust system and explain how the FMAs will be the only indication on active autothrust modes.
Explain the operation of an autothrust system with regard to the following modes: take-off/go-around (TOGA); climb or maximum continuous thrust (MCT), N1 or EPR targeted (THR CLB, THR MCT, N1, THR HOLD, EPR); speed (SPEED, MCP SPD); idle thrust (THR IDLE, RETARD/ARM); landing (RETARD, THR IDLE).
Describe the two main variants of autothrust systems: mode selections available on the FCU/MCP and thrust levers move with autothrust commands; mode selections made using the thrust levers which remain static during autothrust operation.
Explain how flight in turbulence/wind shear giving fluctuating airspeed indications may lead to the autothrust overcompensating in an oscillating manner and that manual thrust may be required to settle the airspeed. Airspeed indications/trend vectors may give an indication of appropriate thrust adjustments but any reaction should not be too aggressive.
Explain the threats associated with the use of autothrust resulting in the pilot losing the sense of energy awareness (e.g. speed, thrust).
Explain the relationship between autopilot pitch modes and autothrust modes, and how the autopilot and autothrust will interact upon selecting modes for one of the systems.
Explain the principles of speed control and how speed can be controlled: by varying the engine thrust; by varying the aircraft pitch.

Explain the potential implications on speed control when the autothrust controls speed and the autopilot pitch channel has a fixed pitch target for the following mode combinations: MCP SPD/SPEED and ALT HOLD/ALT; MCP SPD/SPEED and VSP (climb); MCP SPD/SPEED and VSP (descent).
Explain the potential implications on speed control when the autothrust has a fixed thrust target and the autopilot pitch channel controls speed for the following mode combinations: N1/THR CLB and LVL CHG/OP CLB; ARM/THR IDLE and LVL CHG/OP DES.

COMMUNICATION SYSTEMS

Voice communication, data-link transmission

Definitions and transmission modes

Describe the purpose of a data-link transmission system.
Compare voice communication versus data-link transmission systems.
Describe the communication links that are used in aircraft: high-frequency (HF) communications; very high-frequency (VHF) communications; satellite communications (SATCOM).
Consider the properties of the communication links with regard to: signal quality; range/area coverage; range; line-of-sight limitations; quality of the signal received; interference due to ionospheric conditions; data transmission speed.
Define and explain the following terms in relation to aircraft data-link communications: message/data uplink; message/data downlink.

Systems: architecture, design and operation

Describe the purpose of the ACARS network.
Describe the systems using the ACARS network through the air traffic service unit (ATSU) suite: aeronautical/airline operational control (AOC); air traffic control (ATC).
Explain the purpose of the following parts of the on-board equipment: ATSU communications computer; control and display unit (CDU)/multifunction control and display unit (MCDU); data communication display unit (DCDU); ATC message visual annunciator; printer.
Give examples of airline operations communications (AOC) data-link messages such as: out of the gate, off the ground, on the ground, into the gate (OOOI); load sheet; passenger information (connecting flights); weather reports (METAR, TAF); maintenance reports (engine exceedances); aircraft technical data; free-text messages.
Give examples of ATC data-link messages such as: departure clearance; oceanic clearance; digital ATIS (D-ATIS); controller–pilot data-link communications (CPDLC).

Future air navigation systems (FANSs)

Versions, applications, CPDLC messages, ADS contracts

Describe the existence of the ICAO communication, navigation, surveillance/air traffic management (CNS/ATM) concept.
Explain the two versions of FANSs: FANS A/FANS 1 using the ACARS network; FANS B/FANS 2 using the ACARS network and the aeronautical telecommunication network (ATN).
List and explain the following FANS A/FANS 1 applications: ATS facility notification (AFN); automatic dependent surveillance (ADS); CPDLC.
Compare the ADS application with the secondary surveillance radar function, and the CPDLC application with VHF communication systems.
State that an ATCU can use the ADS application only, or the CPDLC application only, or both of them (not including AFN).
Describe the AFN process for logging on with an ATCU and typical data that will be included in the message.
Describe typical types of CPDLC messages and the typical pilot work practices when requesting or accepting a CPDLC clearance.
List and describe the different types of ADS contracts that are controlled by the ATCU and beyond the control of the pilot: periodic: data sent at set time intervals; on demand: data sent when requested; on event: data sent when an event occurs (e.g. heading change, climb initiated, etc.); emergency mode.
Describe the purpose of the ADS emergency mode contract and highlight the difference to the ATCU controlled contracts.

FLIGHT MANAGEMENT SYSTEM (FMS)/ FLIGHT MANAGEMENT AND GUIDANCE SYSTEM (FMGS)

Design

Purpose, architecture, failures, functions

Explain the purpose of an FMS.
Describe a typical dual FMS architecture including the following components: flight management computer (FMC); CDU/MCDU; cross-talk bus.
Describe the following failures of a dual FMS architecture and explain the potential implications to the pilots: failure of one FMC; failure of one CDU/MCDU; failure of the cross-talk bus.
Describe how the FMS integrates with other systems and gathers data in order to provide outputs depending on its level of complexity.

Explain how the FMS may provide the following functions:
— navigation;
— lateral and vertical flight planning;
— performance parameters.

FMC databases

Navigation database

Explain the purpose of, and describe typical content of, the navigation database.
Describe the 28-day aeronautical information regulation and control (AIRAC) update cycle of the navigation database and explain the reason for having two navigation databases (one active, one standby) and the implication this has to the pilot.
Explain the purpose of typical user-defined waypoints such as: latitude/longitude coordinates; place/bearing/distance (PBD); place/bearing place/bearing (PBX); place/distance (PD).
Explain that the pilot cannot change or overwrite any of the data in the navigation database and that any user-defined waypoints, routes and inputted data will be erased when a different database is activated.
Explain the threats and implications to the pilot of changing the database by error either on the ground or while flying.

Aircraft performance database

Explain the purpose of, and describe the typical content of, the aircraft performance database.
Explain the importance of verifying that the aircraft performance database is based on the correct data, such as engine type and aircraft variant.
Explain that the contents of the aircraft performance database cannot be modified by the pilot.
Explain the purpose of performance factor and how it influences the calculations.
Explain the purpose of cost index (CI) and how it influences the calculations.

Operations, limitations

Data, calculations, position inputs, raw data

Describe typical data that may be provided by the FMS: lateral and vertical navigation guidance; present position; time predictions; fuel predictions; altitude/flight level predictions.
Explain how the FMS will use a combination of inputted/database and measured data in order to calculate projections and provide output data.
Explain the issues and threats using inputted/database data and give examples of consequences of inputting data incorrectly/using incorrect data.
Describe fuel consumption calculations during standard operations and explain typical data that will have an influence on the accuracy of the calculations.
Explain the implications on the accuracy of the calculations during flight in abnormal configurations (such as engine out, gear down, flaps extended, spoilers extended, etc.) if the FMS is unable to detect the failure.
Describe and explain the purpose of an FMS having dedicated radio-navigation receivers that it will tune automatically.
Explain typical position inputs to an FMS: GPS; IRS; DME; VOR; LOC; runway threshold (RWY THR).
Explain how the FMS will create its own FMS position fix and that the FMS calculations will be based on the FMS position. Depending on the type of system, the FMS position may be calculated from: a single source of position data where the most accurate data available at a given time will be used; multiple sources from which a position will be derived using the combined inputs.
Explain the implications of a reduction in available position inputs to the FMS, especially GPS in relation to the capability of performing RNP/PBN approaches.
Explain the difference between following the FMS data compared to following raw data from radio-navigation receivers and describe how there may be limitations for using FMS data as primary source to follow an instrument approach procedure (IAP) such as LOC, VOR or NDB.

Human–machine interface (control and display unit (CDU)/ multifunction control and display unit (MCDU))

Purpose, scratchpad, data input, set-up process

Describe the purpose of a CDU/MCDU.
Describe the typical layout of a CDU/MCDU and the general purpose of the following: screen; line select keys; menu select keys; alphanumerical keys.
Explain the function of the 'scratchpad' part of the screen.
Describe how input of some data is compulsory for the function of the FMS and other data is optional, and that different symbology is used to highlight this: rectangular boxes = compulsory information; dashed line = optional information.
Describe a typical FMS pre-flight set-up process through the CDU/MCDU to cover the most basic information (with the aim to create awareness of required information as this is irrespective of aircraft type and FMS/FMGS make): ident page (who am I = aircraft type/variant, engine type/rating and appropriate navigation database); position

initialisation (where am I = position for aligning the IRS and FMS position); route initialisation (where am I going to = place of departure/destination and alternate(s)); route programming (how will I get there = SIDs, STARS, route (company or otherwise)); performance initialisation (when will I arrive = weights, flap setting, FLEX/assumed temperature/derate, take-off speeds).

ALERTING SYSTEMS, PROXIMITY SYSTEMS

General

Alerting systems according to CS-25 and CS-29

State definitions, category, criteria and characteristics of alerting systems according to CS-25/AMC 25.1322 for aeroplanes and CS-29 for helicopters as appropriate.

Flight warning systems (FWSs)

Annunciations, master warning, master caution, advisory

State the annunciations given by the FWS and typical location for the annunciator(s):

— master warning;
— master caution;
— advisory.

Explain master warning: colour of annunciator: red; nature of aural alerts: continuous; typical failure scenarios triggering the alert.

Explain master caution: colour of the annunciator: amber or yellow; nature of aural alerts: attention-getter; typical failure scenarios triggering the alert.

Describe a typical procedure following a master warning or master caution alert: acknowledging the failure; silencing the aural warning; initiating the appropriate response/procedure.

Explain advisory: colour of the annunciator: any other than red, amber, yellow or green; absence of aural alert; typical scenarios triggering the advisory.

Stall warning systems (SWSs)

Function, types, components

Describe the function of an SWS and explain why the warning must be unique.

Describe the different types of SWSs.

List the main components of an SWS.

Explain the difference between the stall warning speed and the actual stalling speed of the aeroplane.

Stall protection

Function, types

Describe the function of a stall protection system.

Describe the different types of stall protection systems including the difference between mechanical and FBW controls.

Explain the difference between an SWS and a stall protection system.

Overspeed warning

Purpose, aural warning, VMO/MMO pointer

Explain the purpose of an overspeed warning system (VMO/MMO pointer).

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, paragraph 10.b(2), p. 2-GEN-22).

Describe and give examples of VMO/MMO pointer: barber's/barber pole pointer, barber's/barber pole vertical scale.

Take-off warning

Purpose

Explain the purpose of a take-off warning system and list the typical abnormal situations which generate a warning (see AMC 25.703, paragraphs 4 and 5).

Altitude alert system

Function, displays, alerts

Describe the function of an altitude alert system.

Describe different types of displays and possible alerts.

Radio altimeter

Purpose, range, displays, incorrect indications

Explain the purpose of a low-altitude radio altimeter.

Describe the principle of the distance (height) measurement.

Describe the different types of radio-altimeter displays.

Describe how the radio altimeter provides input to other systems and how a radio-altimeter failure may impact on the functioning of these systems.

State the range of a radio altimeter.

Explain the potential implications of a faulty radio-altimeter and how this in particular may affect the following systems: autothrust (flare/retard); ground-proximity warning systems (GPWSs).

Ground-proximity warning systems (GPWSs)

GPWSs: design, operation, indications

Explain the purpose of GPWSs.

Explain inputs and outputs of a GPWS and describe its operating principle.

List and describe the different modes of operation of a GPWS.

Terrain-avoidance warning system (TAWS); other name: enhanced GPWS (EGPWS)

Explain the purpose of a TAWS for aeroplanes and of a HTAWS for helicopters, and explain the difference from a GPWS.

Explain inputs and outputs of a TAWS/HTAWS and describe its working principle.

Give examples of terrain displays and list the different possible alerts.

Give examples of time response left to the pilot according to look-ahead distance, speed and aircraft performances.

Explain why the TAWS/HTAWS must be coupled to a precise-position sensor.

Explain the possibility of triggering spurious TAWS/HTAWS warnings as a result of mismanaging the flight path in the proximity to obstacles: high rate of descent; high airspeed; a combination of high rate of descent and high airspeed.

ACAS/TCAS

Principles and operations

State that ACAS II is an ICAO standard for anti-collision purposes.

Explain that ACAS II is an anti-collision system and does not guarantee any specific separation.

Describe the purpose of an ACAS II system as an anti-collision system.

Describe the following outputs from a TCAS: other intruders; proximate intruders; traffic advisory (TA); resolution advisory (RA).

State that ACAS II will issue commands in the vertical plane only (climb, descent or maintain), and that the commands are complied with as a manual manoeuvre.

Explain that an RA may or may not require any active control input and the implications of reacting instinctively without awareness of actual control inputs required to comply with the RA.

Explain that if two aircraft are fitted with ACAS II, the RA will be coordinated.

State that ACAS II equipment can take into account several threats simultaneously.

State that a detected aircraft without altitude-reporting can only generate a TA; describe typical type of traffic and how this can create distractions during flight in certain areas of significant air traffic activity.

Describe the interaction between the TCAS II system and the transponder, radio altimeter and the air-data computer: antenna used; computer and links with radio altimeter, air-data computer and mode-S transponder.

Explain the principle of TCAS II interrogations.

State the typical standard detection range for TCAS II: 35–40 NM horizontally; approximately 2 000 ft above and below (any setting); extension to approximately 10 000 ft above (ABV selected) or approximately 10 000 ft below (BLW selected).

Explain the principle of 'reduced surveillance'.

Explain that in high-density traffic areas the range may automatically be decreased in order to enable detection of the threats in the proximity of the aircraft due to a limitation of the maximum number of possible intruders the system is able to process.

Identify the equipment which an intruder must be fitted with in order to be detected by TCAS II.

Explain in the anti-collision process: the criteria used to trigger an alarm (TA or RA) are the time to reach the closest point of approach (CPA) (called TAU) and the difference of altitude; an intruder will be classified as 'proximate' when being less than 6 NM and 1 200 ft from the TCAS-equipped aircraft; the time limit to CPA is different depending on aircraft altitude, is linked to a sensitivity level (SL), and state that the value to trigger an RA is from 15 to 35 seconds; in case of an RA, the intended vertical separation varies from 300 to 600 ft (700 ft above FL420), depending on the SL; below 1 000 ft above ground, no RA can be generated; below 1 450 ft (radio-altimeter value) 'increase descent' RA is inhibited; at high altitude, performances of the type of aircraft are taken into account to inhibit 'climb' and 'increase climb' RA.

List and interpret the following information available from TCAS: the different possible statuses of a detected aircraft: 'other', 'proximate', 'intruder'; the appropriate graphic symbols and their position on the horizontal display; different aural warnings.

Explain the indications of a TA and an RA and how an RA will generate a red area on the VSI. Some variants will also include a green area. To manoeuvre the aircraft to comply with the RA, the pilot should 'avoid the red' or 'fly the green'.

Explain that the pilot must not interpret the horizontal track of an intruder upon the display.

INTEGRATED INSTRUMENTS - ELECTRONIC DISPLAYS

Electronic display units

Design, limitations

List the different technologies used, e.g. CRT and LCD, and the associated limitations: cockpit temperature; glare; resolution.

Mechanical integrated instruments

Attitude and director indicator (ADI)/ horizontal situation indicator (HSI)

Describe an ADI and an HSI.

List all the information that can be displayed on either instrument.

Electronic flight instrument systems (EFISs)

Design, operation

List the following parts of an EFIS: control panel; display units; symbol generator; remote light sensor.

Describe the typical layout of the EFIS display units and how there may be a facility to transfer the information from one display unit on to another if a display unit fails.

Explain the need for standby instruments to supplement the EFIS in the event of all the display units failing and the challenge of using these standby instruments, namely their size and position on the flight deck.

Explain the difference between a symbol generator failing and a display unit failing, and the implications if there are redundant symbol generators available.

Describe the purpose of an EFIS control panel and typical selections that may be available: altimeter pressure setting; navigation display (ND) mode selector; ND range selector; ND data selector (waypoints, facilities, constraints, data, etc.); radio-navigation aids selector (VOR 1/2 or ADF 1/2); decision altitude (DA)/decision height (DH) selection.

Primary flight display (PFD), electronic attitude director indicator (EADI)

Describe that a PFD (or an EADI) presents a dynamic colour display of all the parameters necessary to control the aircraft, and that the main layout conforms with the 'basic T' principle: attitude information in the centre; airspeed information on the left; altitude information on the right; heading/track indication lower centre; flight mode annunciation; basic T; take-off and landing reference speeds; minimum airspeed; lower selectable airspeed; Mach number.

Describe the typical design of the attitude information: artificial horizon with aircraft symbol; superimposed flight director command bars.

Describe the typical design of the speed tape: rolling speed scale with numerical read-out of current speed; limiting airspeeds according to configuration; speed trend vector; bug/indication for selected airspeed.

Explain the Mach number indications and how a selected Mach number is presented with the speed bug on a corresponding IAS on the speed tape with the Mach number shown as a numerical indication outside the speed tape.

Describe the typical design of the altitude information: rolling altitude scale with numerical read-out of current altitude; altimeter pressure setting; bug/indication for selected altitude; means of highlighting the altitude if certain criteria are met.

Describe the typical design of the heading/track information: rolling compass scale/rose with numerical read-out of current heading/track; bug/indication for selected heading/track.

Describe the typical design and location of the following information: flight mode annunciators (FMAs); vertical speed indicator including TCAS RA command indications; radio altitude; ILS localiser/glideslope and RNP/PBN, GBAS or SBAS horizontal/vertical flight path deviation indicator; decision altitude/height (DA/H).

Navigation display (ND), electronic horizontal situation indicator (EHSI)

Describe that an ND (or an EHSI) provides a mode-selectable colour flight ND.

List the following four modes typically available to be displayed on an ND unit: MAP (or ARC); VOR (or ROSE VOR); APP (or ROSE LS); PLAN.

List and explain the following information that can be displayed with the MAP (or ARC) mode selected on an ND unit: aircraft symbol, compass scale and range markers; current heading and track (either one may be 'up' depending on selection), true or magnetic; selected heading and track; TAS/GS; wind direction and speed (W/V); raw data radio magnetic indicator (RMI) needles/pointers for VOR/automatic direction-finding equipment (ADF), if selected, including the frequency or ident of the selected navigation facility; route/flight plan data from the FMS; TO/next waypoint data from the FMS; data from the navigation database such as airports, waypoints or navigation facilities as selected; weather radar information; TCAS traffic information (no TCAS commands); TAWS (EGPWS) terrain information; failure flags and messages.

List and explain the following information that can be displayed with the VOR or APP (or ROSE VOR or ROSE LS) mode selected on an ND unit: aircraft symbol and compass scale; current heading and track (either one may be 'up' depending on selection), true or magnetic; selected heading and track; TAS/ground speed (GS); wind direction and speed (W/V); VOR or ILS frequency and identification of the selected navigation aid; VOR selected course, deviation indicator and a TO/FROM indicator in a HSI-type display format when in VOR mode; localiser selected course,

deviation indicator and glideslope indicator in a HSI-type display format when in APP mode. weather radar information; TCAS traffic information (no TCAS commands); TAWS (EGPWS) terrain information; failure flags and messages.
List and explain the following information that can be displayed with the PLAN mode selected on an ND unit: north-up compass rose and range markers; aircraft symbol oriented according to aircraft heading; TAS/GS; wind direction and speed (W/V); route/flight plan data from the FMS; TO/next waypoint data from the FMS; data from the navigation database such as airports, waypoints or navigation facilities as selected; failure flags and messages.
Explain the purpose of PLAN mode and its characteristics such as: no compass information; north is up on the display unit at all times; the centre waypoint is the selected waypoint on the FMS CDU; scrolling through the flight plan on the FMS CDU will shift the map view along the flight path; the aircraft symbol will be positioned in the appropriate place along the flight path; using PLAN mode as the primary mode during flight may lead to disorientation and loss of situational awareness.
Distinguish the difference between the appearance of an EXPANDED or FULL/ROSE mode and how the displayed range differs between them.
Explain the combination of mode and range selection including how selecting the appropriate range and displayed data can improve situational awareness for a given phase of flight.

Engine parameters, crew warnings, aircraft systems, procedure and mission display systems

Purposes of systems, display systems, checklists

State the purpose of the following systems: engine instruments centralised display unit; crew alerting system/aircraft display unit; facility for appropriate on-screen checklists; that the aircraft systems display unit enables the display of normal and degraded modes of operation of the aircraft systems; that the systems/aircraft display unit is able to show pictorial systems diagrams/schematics and associated parameters.
Describe the similarities to EFIS with regard to basic system architecture.
Give the following different names by which engine parameters, crew warnings, aircraft systems and procedures display systems are known: multifunction display unit (MFDU); engine indication and crew alerting systems (EICASs); engine and warning display (EWD); electronic centralised aircraft monitor (ECAM); systems display (S/D).
Give the names of the following different display systems and describe their main functions: vehicle engine monitoring display (VEMD); integrated instruments display system (IIDS).
State the purpose of a mission display unit.
Describe the architecture of each system and give examples of display.
Explain why awareness of the consequences of the actions commanded by the automatic checklist is required.
Explain the limited ability of the computer to assess a situation other than using the exceedance of certain thresholds to trigger the main and subsequent events and programmed actions.
Describe an appropriate procedure for following an on-screen checklist associated with a failure scenario including the following: confirm the failure with the other flight crew member prior to performing any of the actions; seek confirmation prior to manipulating any guarded switches or thrust levers; follow the checklist slowly and methodically; assess the possible implications of making certain selections, such as opening the fuel cross-feed if there is a fuel leak even though the electronic checklist may ask for the action.

Engine first limit indicator

Design, operation, information on display

Describe the principles of design and operation, and compare the different indications and displays available.
Describe what information can be displayed on the screen, when the screen is in the limited composite mode.

Electronic flight bag (EFB)

Purpose, certification, malfunctions

Explain the purpose of the EFB and list typical equipment: computer laptop; tablet device; integrated avionics suite in the aircraft.
Describe the 'class' hardware certification: portable: portable electronic device (PED) that can be used inside or outside the aircraft, is not part of the certified aircraft configuration and does not require tools to remove it from the flight-deck cradle, if one exists; installed: an electronic device that is considered an aircraft part covered by the aircraft airworthiness approval, thus is a minimum equipment list (MEL) item in the event of failure.
Describe the 'type' software certification: type A: applications whose misuse or malfunctions have no adverse effect on flight safety; type B: applications for which evaluation of the hazards presented by misuse or malfunctions is required.
Explain implications of malfunctions with the EFB installation in a fully electronic flight-deck environment: mass and balance calculations; performance calculations; access to charts; access to manuals.

Head-up display (HUD), synthetic vision system (SVS) and enhanced visual system (EVS)

Components, benefits, modes of operation

State the components of a typical HUD installation: HUD projector and stowable combiner; HUD controls such as declutter and dimmer; HUD computer.

Explain the reasons and benefits of having an HUD: increased situational awareness due to reduced need to look inside to view primary flight information; lower minima for both departure and landing; improved accuracy of flying thus reduced susceptibility to enter a state of aircraft upset.
Describe how the HUD replicates the information on the primary flight display (PFD) by showing the following data: altitude; speed, including speed trend; heading; flight path vector (track and vertical flight path); flight mode annunciator (FMA); CAS, TAWS and wind shear command annunciations.
Describe the following modes of operation of an HUD: normal display mode that may automatically adapt the information based on the phase of flight; declutter function.
Describe the principle of SVS: an enhanced database used as reference to provide terrain and ground features to be shown on the PFD; limitations due to being a synthetic image not based on actual sensory information thus not lowering landing minima; implications if aircraft position accuracy becomes reduced.
Describe the principle of EVS: includes external sensors such as infrared cameras to generate a real-time image on the PFD or on the HUD; limitation of the fact that an infrared camera uses temperature and temperature difference in order to produce an image; enables lower minima because of the real-time image, thus enhancing the visibility as experienced by the pilot.

MAINTENANCE, MONITORING AND RECORDING SYSTEMS

Cockpit voice recorder (CVR)

Purpose, components, parameters

Describe the purpose of a CVR, its typical location, and explain the implications of knowingly erasing or tampering with any information or equipment.
List the main components of a CVR: a shock-resistant tape recorder or digital storage associated with an underwater locating beacon (ULB); a cockpit area microphone (CAM); a control unit with the following controls: auto/on, test and erase, and a headset jack; limited flight-deck controls such as erase and test switches.
List the following main parameters recorded on the CVR: voice communications transmitted from or received on the flight deck; the aural environment of the flight deck; voice communication of flight crew members using the aeroplane's interphone system; voice or audio signals introduced into a headset or speaker; voice communication of flight crew members using the public address system, if installed.

Flight data recorder (FDR)

Purpose, components, parameters

Describe the purpose of an FDR and its typical location.
List the main components of an FDR: a shock-resistant data recorder associated with a ULB; a data interface and acquisition unit; a recording system (digital flight data recorder); two control units (start sequence, event mark setting); limited flight-deck controls, but includes an event switch.
List the following main parameters recorded on the FDR: time or relative time count; attitude (pitch and roll); airspeed; pressure altitude; heading; normal acceleration; propulsive/thrust power on each engine and flight-deck thrust/power lever position, if applicable; flaps/slats configuration or flight-deck selection; ground spoilers or speed brake selection.
State that additional parameters can be recorded according to FDR capacity and applicable operational requirements.

Maintenance and monitoring systems

Aeroplane condition monitoring system (ACMS): general, design, operation

State the purpose of an ACMS.
Describe the structure of an ACMS including: inputs: aircraft systems (such as *a*ir conditioning, autoflight, flight controls, fuel, landing gear, navigation, pneumatic, APU, engine), MCDU; data management unit; recording unit: digital recorder; outputs: printer, ACARS or ATSU.
State that maintenance messages sent by an ACMS can be transmitted without crew notification.
Explain that data from the ACMS can be used as part of an FDM and safety programme.
Explain that the FDM program collects data anonymously; however, grave exceedance of parameters may warrant a further investigation of the event by the operator.
Explain the purpose of FDM as a system for identifying adverse safety trends and tailoring training programmes in order to enhance the overall safety of the operation.

DIGITAL CIRCUITS AND COMPUTERS

Digital circuits and computers

General, definitions and design

Define a 'computer' as a machine for manipulating data according to a list of instructions.
Explain the term 'bus' being used as a term for a facility (wiring, optical fibre, etc.) transferring data between different parts of a computer, both internally and externally.
Define the terms 'hardware' and 'software'.

With the help of the relevant 022 references, give examples of airborne computers and list the possible peripheral equipment for each system, such as: ADC with pitot probe(s), static port(s) and indicators; FMS with GPS, CDU/MCDU and ND; GPWS with radio altimeter, ADC and ND.

031. MASS AND BALANCE - AEROPLANES

PURPOSE OF MASS-AND-BALANCE CONSIDERATIONS

Mass limitations

Importance with regard to structural limitations

Describe the relationship between aircraft mass and structural stress. Remark: See also Subject 021 01 01 00.

Describe why mass must be limited to ensure adequate margins of strength.

Importance with regard to performance. Remark: See also Subjects 032/034 and 081/082.

Describe the relationship between aircraft mass and aircraft performance.

Describe why aircraft mass must be limited to ensure adequate aircraft performance.

Centre-of-gravity (CG) limitations

Importance ~~with~~ regard to stability and controllability. Remark: See also Subjects 081/082.

Describe the relationship between CG position and stability/controllability of the aircraft.

Describe the consequences if CG is in front of the forward limit.

Describe the consequences if CG is behind the aft limit.

Importance with regard to performance. Remark: See also Subjects 032/034 and 081/082.

Describe the relationship between CG position and aircraft performance.

Describe the effects of CG position on performance parameters (speeds, altitude, endurance and range).

LOADING

Terminology

Mass terms

Define the following mass terms: basic empty mass;. dry operating mass;. operating mass;. take-off mass;. landing mass;. ramp/taxi mass;. in-flight mass (gross mass);. zero fuel mass.

Load terms (including fuel terms) Remark: See also Subject 033.

Define the following load terms: payload/traffic load;. block fuel;. taxi fuel;. take-off fuel;. trip fuel;. reserve fuel (contingency, alternate, final reserve and additional fuel);. extra fuel.

Calculate the mass of particular components from other given components.

Convert fuel mass, fuel volume and fuel density given in different units used in aviation.

Mass limits

Structural limitations

Define the maximum zero fuel mass.

Define the maximum ramp/taxi mass.

Define the maximum take-off mass.

Define the maximum landing mass.

Performance and regulated limitations

Describe the following performance and regulated mass limitations: performance-limited take-off mass;. performance-limited landing mass;. regulated take-off mass;. regulated landing mass.

Cargo compartment limitations

Describe the maximum floor load (maximum load per unit of area).

Describe the maximum running load (maximum load per unit of fuselage length).

Mass calculations

Maximum masses for take-off and landing

Calculate the maximum mass for take-off (regulated take-off mass) given mass-and-load components and structural/ performance limits.

Calculate the maximum mass for landing (regulated landing mass) given mass-and-load components and structural/ performance limits.

Calculate the allowed mass for take-off.

Allowed traffic load and fuel load

Calculate the maximum allowed traffic load and fuel load in order not to exceed the given allowed take-off mass.

Calculate 'under load'/'over load' given the allowed mass for take-off, operating mass and actual traffic load.

Use of standard masses for passengers, baggage and crew

Extract the appropriate standard masses for passengers, baggage and crew from relevant documents or operator requirements.

Calculate the traffic load by using standard masses.

MASS-AND-BALANCE DETAILS OF AIRCRAFT

Contents of mass-and-balance documentation

Datum, moment arm

State where the datum and moment arms for aircraft can be found.

Extract the appropriate data from given documents.

Define 'datum' (reference point), 'moment arm' and 'moment'.

CG position as distance from datum

State where the CG position for an aircraft at basic empty mass can be found.

State where the CG limits for an aircraft can be found.

Describe the different forms in presenting CG position as distance from datum or other references.

Explain the meaning of centre of gravity (CG).

CG position as percentage of mean aerodynamic chord (% MAC). Remark: Knowledge of the definition of MAC is covered under Subject 081 01 01 05.

Extract MAC information from aircraft documents.

Explain the principle of using % MAC for the description of the CG position.

Calculate the CG position as % MAC.

Longitudinal CG limits

Extract the appropriate data from given sample documents.

Details of passenger and cargo compartments

Extract the appropriate data (e.g. seating schemes, compartment dimensions and limitations) from given sample documents.

Details of fuel system relevant to mass-and-balance considerations

Extract the appropriate data (e.g. fuel-tank capacities and fuel-tank positions) from given sample documents.

Explain aircraft CG movement as flight progresses given location of fuel tank (inner wing, outer wing, central, additional aft central, horizontal stabiliser) and mass of fuel consumed from that tank and aeroplane's previous CG.

Explain advantages and risks associated with fuel tanks in the aeroplane's fin or horizontal stabiliser.

Determination of aircraft empty mass and CG position by weighing

Weighing of aircraft (general aspects)

Describe the general procedure and regulations relating to when an aircraft should be weighed, reweighed or data recalculated.

Remark: See the applicable operational requirements.

Extract and interpret entries from/in 'mass (weight) report' of an aircraft.

Calculation of mass and CG position of an aircraft using weighing data

Calculate the mass and CG position of an aircraft from given reaction forces on jacking points.

Extraction of basic empty mass (BEM) and CG data from aircraft documentation

BEM or dry operating mass (DOM)

Extract values for BEM or DOM from given documents.

CG position or moment at BEM/DOM

Extract values for CG position and moment at BEM or DOM from given documents.

Deviations from standard configuration

Extract values from given documents for deviation from standard configuration as a result of varying crew, optional equipment, optional fuel tanks, etc.

DETERMINATION OF CG POSITION

Methods

Arithmetic method

Calculate the CG position of an aircraft by using the formula: CG position = sum of moments / total mass.

Graphic method

Determine the CG position of an aircraft by using the loading graphs given in sample documents.

Index method

Explain the principle of the index method.

Define the terms 'index' and 'dry operating index' (DOI), and calculate the DOI given the relevant formula and data.

Explain the advantage(s) of the index method.

Load and trim sheet

General considerations

Explain the principle and the purpose of load sheets.

Explain the principle and the purpose of trim sheets.

Load sheet/balance schedule and CG envelope for light aeroplanes and for helicopters

Add loading data and calculate masses in a sample load sheet/balance schedule.

Calculate moments and CG positions.

Check CG position at zero fuel mass and take-off mass to be within the CG envelope including last-minute changes, if applicable.

Load sheet for large aeroplanes

Complete a sample load sheet to determine the 'allowed mass for take-off', 'allowed traffic load' and 'under load'.
Explain the purpose of each load sheet section.
Explain that the purpose of boxed maximum figures in load sheet sections is to cross-check the actual and limiting mass values.
Complete and cross-check a sample load sheet.

Trim sheet for large aeroplanes

Explain the purpose of the trim sheet and the methods to determine the CG position.
Check if the zero fuel mass CG or index is within the limits.
Determine the fuel index by using the 'fuel index correction table' and determine the CG position as % MAC.
Check that the take-off mass CG or index are within the limits.
Determine 'stabiliser trim units' for take-off.
Explain the difference between certified and operational CG limits.
Determine the zero fuel mass CG or index.
Explain the relationship between pitch control and CG position and the operational significance.

Other methods to present load and trim information

Describe information from other methods of presenting load and balance information, e.g. aircraft communications addressing and reporting system (ACARS), electronic flight bags (EFBs), and the 'less paper in the cockpit' (LPC) software.

Repositioning of CG

Repositioning of CG by shifting the load

Calculate the mass to be moved over a given distance, or to/from given compartments, to establish a defined CG position.
Calculate the distance to move a given mass to establish a defined CG position.
Describe the methods to check that cargo has been loaded in correct position in relation to the loading manifest, including identifying hazard of cargo loaded in reverse order (visual inspection of one or more unit load devices (ULDs).
Determine whether CG remains within limits if cargo has been loaded in incorrect order or at incorrect location.

Repositioning of CG by additional load or ballast or by load or ballast removal

Calculate the amount of additional load or ballast to be loaded at or removed from a given position or compartment to establish a defined CG position.
Calculate the loading position or compartment for a given amount of additional load or ballast to establish a defined CG position.

CARGO HANDLING

Types of cargo

Types of cargo (general aspects)

Describe the typical types of cargo, e.g. containerised cargo, palletised cargo, bulk cargo, and the advantages of containerised and palletised cargo.

Floor-area load and running-load limitations

Floor-area load and running-load limitations in cargo compartments

Calculate the required floor-contact area for a given load to avoid exceeding the maximum permissible floor load of a cargo compartment.
Calculate the maximum mass of a container with given floor-contact area to avoid exceeding the maximum permissible floor load of a cargo compartment.
Calculate the linear load distribution of a container to avoid exceeding the maximum permissible running load.

Securement of load

Securement of load (reasons and methods)

Explain the reasons to restrain or secure cargo and baggage.
Describe the basic methods to restrain or secure loads
(unit load devices secured by latches on roller tracks or to tie down points by straps; bulk cargo restrained by restraining nets attached to attachment points and tie-down points).

032. PERFORMANCE - AEROPLANES

GENERAL

Performance legislation

Applicability of airworthiness requirements of CS-23 and CS-25

Describe the application of certification specification (CSs) with regard to the different kinds of aeroplanes.

Describe the general differences between aeroplanes certified according to CS-23 (CS 23.1, CS 23.3) and CS-25 (CS 25.1, CS 25.20).

Operational regulations and safety

Describe the basic concept that the applicable operational requirements differ depending on aeroplane performance.

Describe the performance classes for commercial air transport according to the applicable operational requirements.

Performance and safety

State that aeroplane performance required for commercial air transport may limit the weight of a dispatched aeroplane in order to achieve a sufficient level of safety.

Describe that the minimum level of safety required for commercial air transport is ensured through the combination of airworthiness requirements and operational limitations, i.e. the more stringent airworthiness requirements of CS-25 enable a wider range of operating conditions for these aeroplanes.

Performance definitions and safety factors

Describe measured performance and explain how it is determined.

Describe gross performance.

Describe net performance and safety factors.

Describe that the size of a safety factor depends on the likelihood of the event and the range of the measured performance data.

Describe the relationship between net and gross take-off and landing distances, and net and gross climb and descent gradients.

General performance theory

Definitions and terms

Define the terms 'climb angle' and 'climb gradient'.

Define the terms 'flight-path angle' and 'flight-path gradient'.

Define the terms 'descent angle' and 'descent gradient'.

Explain the difference between climb/descent angle and flight-path angle.

Define 'absolute ceiling'.

Describe 'clearway' and 'stopway' according to CS-Definitions.

Describe: take-off run available (TORA); take-off distance available (TODA); accelerate-stop distance available (ASDA); and determine each from given data or appropriate aerodrome charts.

Describe 'screen height' including its various values.

Define the terms 'range' and 'endurance'.

Define an aeroplane's 'specific range' (SR) in terms of nautical air miles (NAM) per unit of fuel, and 'specific range over the ground' (SRG) in terms of nautical ground miles (NGM) per unit of fuel.

Define the power available and power required.

Variables influencing performance

Name the following factors that affect aeroplane performance: pressure altitude and temperature, wind, aeroplane weight, aeroplane configuration, aeroplane anti-skid status, aeroplane centre of gravity (CG), aerodrome runway surface, and aerodrome runway slope.

Describe how, for different density altitudes, the thrust and power available vary with speed for a propeller-driven aeroplane.

Describe how, for different density altitudes, the thrust and power available vary with speed for a turbojet aeroplane.

Describe how, for different density altitudes, the drag and power required vary with indicated airspeeds (IAS) and true airspeeds (TAS).

Describe how, for different aeroplane weights and configurations, the drag and power required vary with IAS and TAS.

Level flight, range and endurance

Steady level flight

Explain how drag (thrust) and power required vary with speed in straight and level flight.

Explain the effect of excess thrust and power on speed in level flight.

Interpret the 'thrust/power required' and 'thrust/power available' curves in straight and level flight.

Describe how the maximum achievable straight and level flight IAS and TAS vary with altitude.

Describe situations in which a pilot may elect to fly for 'maximum endurance' or 'maximum range'.

Range

Define a turbojet aeroplane's specific fuel consumption (SFC) and describe how it affects fuel flow and specific range.

Define a propeller-driven aeroplane's SFC and describe how it affects fuel flow and specific range.

Explain the optimum speed for maximum SR for a turbojet aeroplane in relation to the drag curve.

Explain the optimum speed to achieve maximum SR for a propeller-driven aeroplane in relation to the power required and drag graphs.
Explain the effect of aeroplane weight and CG position on fuel consumption, range and the optimum speed for maximum SR.
State how a turbojet engine's SFC varies with temperature and thrust setting.
Explain how SR for a turbojet aeroplane varies with altitude and under different meteorological conditions.
Explain how SRG for a propeller-driven aeroplane varies with altitude and under different meteorological conditions.
Explain the effect of weight on the optimum altitude for maximum range.
Describe the effect of wind on SRG and the optimum speed for SRG , when compared to SR, and the optimum speed for SR.

Maximum endurance

Explain fuel flow in relation to TAS and thrust for a turbojet aeroplane.
State the speed for maximum endurance for a turbojet aeroplane.
Explain fuel flow in relation to TAS and thrust for a propeller-driven aeroplane.
State the speed for maximum endurance for a propeller-driven aeroplane and the disadvantages of holding at this speed (e.g. high angle of attack (AoA) and lack of speed stability).
Explain the effect of wind and altitude on endurance, and the maximum endurance speed for a turbojet aeroplane.
Explain the effect of wind and altitude on endurance, and the maximum endurance speed for a propeller-driven aeroplane.
Describe the benefits of managing your en-route airspeed to reduce or avoid holding time, and the operational situations when it could be used (commanded by the pilot or air traffic control (ATC), when delays at arrival airport occur).

Climbing

Climbing (climb performance)

Resolve the forces during a steady climb.
Define and explain the following terms: critical engine; speed for best angle of climb (Vx); speed for best rate of climb (Vy).
Explain climb performance in relation to the thrust available and thrust required (angle of climb), and power available and power required (rate of climb).
Explain the meaning and effect of 'excess thrust' and 'excess power' in a steady climb.
Interpret the 'thrust/power required' and 'thrust/power available' curves in a steady climb.
State the difference between climb angle and gradient.
Explain the effect of weight on the climb angle and rate of climb, and the speed for best angle and best rate of climb.
Explain the effects of pressure altitude and temperature, including an inversion on climb performance (angle and rate of climb).
Explain the effect of configuration on climb performance (angle and rate of climb, and Vx and Vy).
Describe the effect of engine failure on climb performance (angle and rate of climb, and Vx and Vy).
Calculate the all-engine and one-engine-out climb gradient from given values of engine thrust and aeroplane drag and weight.

Descending

Descending (descent performance)

Resolve the forces during steady descent and in the glide.
Explain descent performance in relation to thrust available and thrust required (drag), and power available and power required.
Explain the meaning of 'excess thrust required' (excess drag) and 'excess power required' in a steady descent.
Interpret the 'thrust/power required' and 'thrust/power available' curves in a steady descent.
Explain the effect of mass, altitude, wind, speed and configuration on the glide descent.
Explain the effect of mass, altitude, wind, speed and configuration on the powered descent.

CS-23/APPLICABLE OPERATIONAL REQUIREMENTS PERFORMANCE CLASS B - THEORY

Airworthiness requirements

Airworthiness requirements and definitions

Define the following speeds: stall speeds VS, VS0 and VS1; rotation speed VR; speed at 50 ft above the take-off surface level; reference landing speed VREF.
Describe the limitations on VR, on the speed at 50 ft above the take-off surface and on VREF, and given the appropriate stall speed, estimate the values based on these limitations for a single-engine, class B aeroplane.
Describe the limitations on VR, on the speed at 50 ft above the take-off surface and on VREF, and given the appropriate stall speed, estimate the values based on these limitations for a multi-engine, class B aeroplane.

Describe the European Union airworthiness requirements according to CS-23 relating to aeroplane performance (CS-23 SUBPART A - GENERAL, PERFORMANCE, CS 23.45 to CS 23.78 inclusive).
Define and identify the critical engine of a multi-engine propeller aeroplane.
Explain the effect of an engine failure on the power required, the total drag (thrust required) and climb performance of a multi-engine aeroplane.
Explain the effect of engine failure on the minimum control speed of a multi-engine aeroplane under given conditions (temperature and pressure altitude).

Take-off and landing

Take-off and landing (definitions and effects)

Define the following distances and masses: take-off distance; landing distance; ground-roll distance; maximum allowed take-off mass; maximum allowed landing mass.
Explain the effect of flap-setting on the take-off, landing and ground-roll distances.
Explain the effects of the following runway (RWY) variables on take-off distances: RWY slope; RWY surface conditions: dry, wet and contaminated; RWY elevation.
For both fixed-pitch and constant-speed propeller aeroplanes, explain the effect of airspeed on thrust during the take-off run.
Describe the effects of brake release before take-off power is set on the TOD and ASD.
Explain the effect of wind on take-off and landing distances, and determine the actual headwind/tailwind component given the runway direction, wind speed and direction, by use of wind component graphs, mathematical calculations, and rule of thumb.
Explain why an aeroplane has maximum crosswind limit(s) and determine the crosswind component given the runway direction, wind speed and direction, by use of wind component graphs, mathematical calculations, and rule of thumb.
Explain the percentage of accountability for headwind and tailwind components during take-off and landing calculations.
Explain the effect of runway conditions on the landing distance.
Explain the effects of pressure altitude and temperature on the take-off distance, take-off climb, landing distance and approach climb.
Describe the landing airborne distance and ground-roll distance and estimate the effect on the landing distance when the aeroplane is too fast or too high at the screen.
Describe the take-off flight path for a multi-engine, class B aeroplane.
Describe the dimensions of the take-off flight path accountability area (domain).

Climb, cruise and descent

Climb, cruise and descent (requirements and calculations)

Describe the climb and en-route requirements according to the applicable operational requirements.
For a single-engine aeroplane, calculate the expected obstacle clearance (in visual meteorological conditions (VMC)) given gross climb performance, obstacle height and distance from reference zero.
For a single-engine aeroplane, calculate the net glide gradient and net glide distance, given aeroplane altitude, terrain elevation, gross gradient or lift/drag ratio (L/D ratio), and headwind or tailwind component.

CS-23/APPLICABLE OPERATIONAL REQUIREMENTS PERFORMANCE CLASS B - USE OF AEROPLANE PERFORMANCE DATA FOR SINGLE- AND MULTI-ENGINE AEROPLANES

Use of aeroplane performance data

Take-off

Determine the field-length-limited take-off mass and take-off speeds given defactored distance, configuration, pressure altitude, temperature and headwind/tailwind component.
Determine the accelerate-go distance and accelerate-stop distance data.
Determine the ground-roll distance and take-off distance from graphs.
Determine the all-engine-out and critical-engine-out take-off climb data.
Determine take-off flight path for a MEP aeroplane of given mass and given airfield conditions, and calculate the obstacle clearance based on the take-off flight path.
Determine the minimum headwind or maximum tailwind component required for take-off for a given mass and given airfield conditions.
Given take-off run available (TORA), TODA and ASDA, slope and surface conditions, calculate the defactored distance to be used for commercial air transport using the appropriate take-off graphs.
Calculate the minimum TORA or TODA for commercial air transport given the defactored take-off distance or run, runway surface and slope.

Climb

Determine rate of climb.
Calculate obstacle clearance climb data.

Determine the still-air and flight-path gradients for given IAS, altitude, temperature, aeroplane weight and, if relevant, wind component.

Landing

Determine the field-length-limited landing mass and landing speeds given defactored distance, configuration, pressure altitude, temperature and headwind or tailwind component.
Determine landing climb data in the event of balked landing.
Determine landing distance and ground-roll distance for given flap position, aeroplane weight and airfield data.
Calculate, given the landing distance available (LDA), slope and surface type and condition, the defactored distance to be used for commercial air transport using the appropriate landing graphs.
Calculate the minimum landing distance (LD) that must be available for commercial air transport given the defactored landing distance, runway surface and slope.

CS-25/APPLICABLE OPERATIONAL REQUIREMENTS PERFORMANCE CLASS A - THEORY

Take-off

Take-off performance, definitions of and relationships between terms

Explain the forces affecting the aeroplane during the take-off run.
State the effects of thrust-to-weight ratio and flap-setting on ground roll.
Describe the European Union airworthiness requirements according to CS-25 relating to large aeroplane performance (General and Take-off) (SUBPART B - FLIGHT PERFORMANCE: CS 25.101 to CS 25.109 inclusive, and CS 25.113).
Describe the terms 'aircraft classification number' (ACN) and 'pavement classification number' (PCN), and the requirements and hazards of operating on aerodrome surfaces with PCNs smaller than the ACNs.
Define and explain the following speeds in accordance with CS-25 or CS-Definitions: reference stall speed (VSR); reference stall speed in a specific configuration (VSR1); 1-g stall speed at which the aeroplane can develop a lift force (normal to the flight path) equal to its weight (VS1g); minimum control speed with critical engine inoperative (VMC); minimum control speed on or near the ground (VMCG); minimum control speed at take-off climb (VMCA); engine failure speed (VEF); take-off decision speed (V1); rotation speed (VR); take-off safety speed (V2); minimum take-off safety speed (V2MIN); minimum unstick speed (VMU); lift-off speed (VLOF); maximum brake energy speed (VMBE); maximum tyre speed (VMax Tyre).
Explain the interdependence between the above-mentioned speeds where relevant.
Define the following distances in accordance with CS-25: take-off run with all engines operating and one-engine-inoperative; take-off distance with all engines operating and one-engine-inoperative; accelerate-stop distance with all engines operating and one-engine-inoperative.
Explain how loss of TORA due to alignment is accounted for.
Explain the effect of the interdependency of relevant speeds in 032 04 01 01 (05) and the situations in which these interdependencies can cause speed and performance restrictions.

Take-off distances

Explain the effects of the following runway (RWY) variables on take-off distances: RWY slope; RWY surface conditions: dry, wet and contaminated; RWY elevation.
Explain the effects of the following aeroplane variables on take-off distance: aeroplane mass; take-off configuration; bleed-air configurations.
Explain the effects of the following meteorological variables on take-off distances: wind; temperature; pressure altitude.
Explain the consequence of errors in rotation technique on take-off distance: early and late rotation; too high and too low rotation angle; too high and too low rotation rate.
Compare the take-off distance for specified conditions and configuration for all engines operating and one-engine-inoperative.
Explain the effect of using clearway on the field-length-limited take-off mass.
Explain the influence of aeroplane mass, air density and flap settings on V1, V2 and V2MIN and thereby on take-off distance.
Explain the effect of an error in V1 on the resulting one-engine-out take-off distance.

Accelerate-stop distance

Explain how the accelerate-stop distance is affected by given conditions and configuration for all engines operating and one-engine-inoperative.
Explain the effect of using a stopway on the field-length-limited take-off mass.
Explain the effect of an error in V1 on the resulting accelerate-stop distance.
Explain the effect of runway slope or wind component on the accelerate-stop distance.
Explain how the accelerate-stop distance is determined and discuss the deceleration procedure.
Explain how the accelerate-stop distance is affected by the use of brakes, anti-skid, reverse thrust, ground spoilers (lift dumpers) and by brake energy absorption limits, delayed temperature rise and brake temperature indication.

Explain the hazards of rejecting a take-off from high ground speed or high take-off mass, and how to manage these hazards.

Balanced field length concept

Define the term 'balanced field length'.

Describe the relationship between take-off distance and accelerate-stop distance, and identify on a diagram the balanced field length and balanced V1.

Describe the applicability of a balanced field length.

Unbalanced field length concept

Describe the applicability of an unbalanced field length.

Explain the effect of additional stopway on the allowed take-off mass and appropriate V1 when using an unbalanced field.

Explain the effect of additional clearway on the allowed take-off mass and appropriate V1 when using an unbalanced field.

Field-length-limited take-off mass (FLLTOM)

Explain the factors that affect the FLLTOM.

Explain the concept of a 'range of V1' and explain reasons for the placement of the designated V1 towards the faster or slower end of the range.

Contaminated runways

Define a 'contaminated runway', 'wet runway', and a 'dry runway'.

Describe the different types of contamination: wet or water patches, rime- or frost-covered, dry snow, wet snow, slush, ice, compacted or rolled snow, frozen ruts or ridges.

Source: ICAO Annex 15, Appendix 2

Identify the difference between friction coefficient and estimated surface friction.

Source: ICAO Annex 15, Appendix 2

State that when friction coefficient is 0.40 or higher, the expected braking action is good.

Source: ICAO Annex 14, Vol. I, Attachment A

Define the different types of hydroplaning.

Source: NASA TM-85652, Tire Friction Performance, pp. 6 to 9

Explain the difference between the two dynamic hydroplaning speeds and state which of them is the most limiting for an aircraft operating on a wet runway.

Source: NASA TM-85652, Tire Friction Performance, p. 8

State that some wind limitations may apply in case of contaminated runways. Those limitations are to be found in Part B of the Operations Manual - Limitations.

State that the procedures associated with take-off and landing on contaminated runways are to be found in Part B of the Operations Manual - Normal procedures.

State that the performance associated with contaminated runways is to be found in Part B of the Operations Manual - Performance.

Take-off climb

Explain the difference between the flat-rated and non-flat-rated part in performance charts.

State the differences in climb-gradient requirements for two-, three- and four-engined aeroplanes.

Explain the effects of aeroplane configuration and meteorological conditions on the take-off climb.

Determine the climb-limited take-off mass.

Obstacle-limited take-off

Describe the operational regulations for obstacle clearance in the net take-off flight path (NTOFP).

Define the actual and NTOFP with one-engine-inoperative in accordance with CS-25.

Explain the effects of aeroplane configuration and meteorological conditions on the obstacle-limited take-off mass.

Describe the segments of the actual take-off flight path.

Describe the changes in the configuration, power, thrust and speed in the NTOFP climb segments.

State the standard maximum bank angle(s) in the first and second segment, and determine the effect on the stall speed and implication on V2.

Explain the influence of airspeed selection, acceleration and turns on the climb gradient.

Describe the European Union airworthiness requirements according to CS-25 relating to aeroplane performance take-off climb and flight path (SUBPART B - FLIGHT PERFORMANCE: CS 25.111, CS 25.115, CS 25.117 and CS 25.121)

Performance-limited take-off mass (PLTOM) and regulated take-off mass (RTOM) tables

Define PLTOM and RTOM.

Describe the use of RTOM tables or similar to find PLTOM and how this can also be done using an EFB.

Interpret what take-off limitation (field length, obstacle, climb, structural, etc.) is restricting a particular RTOM as it is presented in RTOM tables or similar.

Describe why data from an EFB can differ from data derived from RTOM tables or similar.

Take-off performance on wet and contaminated runways
Explain the differences between the take-off performance determination on a wet or contaminated runway and on a dry runway.
Describe a wet V1 and explain the consequences of using a wet V1.
Describe the hazards, effects and management of operating from a contaminated runway.
Describe displacement drag, impingement drag, and the methods to monitor acceleration.
Explain the benefits and implications of using a derated take-off on a contaminated runway.
Use of reduced (flexible or flex) and derated thrust
Explain the advantages and disadvantages of using reduced (flex) and derated thrust.
Explain the difference between and principles behind reduced (flex) and derated thrust.
Explain when reduced (flex) and derated thrust may and may not be used.
Explain the effect of using reduced (flex) and derated thrust on take-off performance including take-off speeds, take-off distance, climb performance and obstacle clearance.
Explain the assumed temperature method for determining reduced (flex) thrust performance.
Take-off performance using different take-off flap settings
Explain the advantages and disadvantages of using different take-off flap settings to optimise the performance-limited take-off mass (PLTOM).
Determine the optimum flap position and PLTOM from given figures.
Take-off performance using increased V2 speeds ('improved climb performance')
Explain the advantages and disadvantages of the increased V2 procedure.
Explain under what circumstances this procedure can be used.
Explain the hazards of the fast V1 and VLOF speeds associated with the increased V2 procedure and how they can be managed.
Brake-energy and tyre-speed limit
Explain the effects on take-off performance of brake-energy and tyre-speed limits.
Explain under what conditions they are more likely to become limiting.
Climb
Climb techniques
Explain the effect of climbing at constant IAS on: TAS; Mach number; climb gradient; rate of climb.
Explain the effect of climbing at constant Mach number on: TAS; IAS; climb gradient; rate of climb.
Explain the correct sequence of climb speeds for turbojet transport aeroplanes.
Determine the effect on TAS when climbing in and above the troposphere at constant Mach number.
Influence of variables on climb performance
Explain the effect on the operational speed limit when climbing at constant IAS and at constant Mach number.
Explain the term 'crossover altitude' which occurs during the climb speed schedule (IAS–Mach number).
Cruise
Long-range cruise
Define the term 'long-range cruise'.
Explain the differences between flying at long-range speed and maximum-range speed with regard to fuel-flow and speed stability.
Cruise altitudes
Define the term 'optimum cruise altitude'.
Explain the factors that affect optimum cruise altitude.
Explain the factors that can affect or limit the maximum operating cruise altitude.
Explain the purpose of, and operational reasons for, a step climb and when such a climb would be initiated for optimum range.
Describe the buffet onset boundary (BOB) and determine the high- and low-speed buffet (speed/Mach number only).
Analyse the influence of bank angle, mass and the 1.3g buffet margin on a step climb.
Describe that the high-speed buffet can occur at speeds slower or faster than MMO.
Explain the reasons why a step climb may not be used (e.g. for short sectors, advantageous winds, avoiding turbulence, and due to air traffic restrictions).
Cost index (CI)
Describe 'cost index'.
Describe the reason for economical cruise speed.
Describe the effect of cost index on climb, cruise and descent speeds.
En-route one-engine-inoperative
Drift-down
Describe the determination of en-route flight-path data with one-engine-inoperative in accordance with CS 25.123.
Describe the minimum obstacle-clearance height prescribed in the applicable operational requirements.

Describe the optimum speed that the pilot should select during drift-down.
Explain the influence of deceleration on the drift-down profiles.
Influence of variables on the en-route one-engine-inoperative performance
Describe and explain the factors which affect the en-route net drift-down flight path.
Descent
Descent techniques
Explain the effect of descending at constant Mach number.
Explain the effect of descending at constant IAS.
Explain the correct sequence of descent speeds for turbojet transport aeroplanes.
Determine the effect on TAS when descending in and above the troposphere at constant Mach number.
Describe the following limiting speeds for descent: maximum operating speed (VMO); . maximum Mach number (MMO).
Explain the effect of a descent at constant Mach number on the margin to low- and high-speed buffet.
Energy management in the descent
Explain the advantages and principle of a continuous descent.
Describe energy management in terms of chemical, potential and kinetic energy.
Describe the effect of increasing/decreasing headwind and tailwind on profile management.
Describe the effect of the Mach number to IAS transition (speed conversion) on profile management.
Describe situations during the descent and approach in which a pilot could find that an aeroplane flies high or fast, and explain how the pilot can manage descent angle/excess energy.
Approach and landing
Approach requirements
Describe the CS-25 requirements for the approach climb (CS 25.121).
Describe the CS-25 requirements for the landing climb.
Explain the effect of temperature and pressure altitude on approach and landing-climb performance.
Landing-field-length and landing-speed requirements
Describe the landing distance determined according to CS 25.125 ('demonstrated' landing distance).
Describe the landing-field-length requirements for dry, wet and contaminated runways and the applicable operational requirements.
Define the 'landing distance available' (LDA).
Define and explain the following speeds in accordance with CS-25 or CS-Definitions: reference stall speed in the landing configuration (VSR0); reference landing speed (VREF); - minimum control speed, approach and landing (VMCL).
Influence of variables on landing performance
Explain the effect of runway slope, surface conditions and wind on the maximum landing mass for a given landing distance available in accordance with the applicable operational requirements.
Explain the effect on landing distance and maximum allowable landing mass of the following devices affecting deceleration: reverse; anti-skid; ground spoilers or lift dumpers; autobrakes.
Explain the effect of temperature and pressure altitude on the maximum landing mass for a given landing distance available.
Explain the effect of hydroplaning on landing distance required and methods of managing landing on contaminated or wet runways.
Quick turnaround limit
Describe how brake temperature limits the turnaround times.

CS-25/APPLICABLE OPERATIONAL REQUIREMENTS PERFORMANCE CLASS A - USE OF AEROPLANE PERFORMANCE DATA
Take-off
Take-off (performance data)
Determine from given graphs the field-lenght-limited take-off mass (FLLTOM) and describe situations in which this limitation could be most restrictive for take-off.
Determine from given graphs the climb-limited take-off mass and describe situations in which this limitation could be most restrictive for take-off.
Determine from given graphs the obstacle-limited mass and describe situations in which this limitation could be most restrictive for take-off.
Determine from given graphs the tyre-speed-limited take-off mass.
Determine from given graphs the maximum brake-energy-limited take-off mass.
Determine the take-off V speeds for the actual take-off mass.
Determine the maximum take-off mass using given RTOM tables.
Using RTOM tables, determine the take-off V speeds for the actual take-off weight using appropriate corrections.

Determine the assumed/flex temperature and take-off V speeds using the RTOM tables.
Calculate the break cooling time following a rejected take-off given appropriate data.
Drift-down and stabilising altitude
Drift-down and stabilising altitude (performance data)
Determine the one-engine-out net stabilising altitude (level-off altitude) from given graphs/tables.
Determine the maximum mass at which the net stabilising altitude with one-engine-out clears the highest relevant obstacle by the required clearance margin.
Determine, using drift-down graphs, fuel used, time and distance travelled in a descent from a cruise flight level to a given altitude.
Landing
Landing (performance data)
Determine the field length required for landing with a given landing mass from the aeroplane performance data sheets.
Determine the landing and approach climb-limited landing mass from the aeroplane performance data sheets.
Calculate the maximum allowable landing mass as the lowest of: approach-climb- and landing-climb-limited landing mass; landing-field-length-limited landing mass; structural-limited landing mass.
Determine the brake cooling time for different landing masses using the aeroplane performance data sheets.

033. FLIGHT PLANNING AND MONITORING

FLIGHT PLANNING FOR VFR FLIGHTS. Remark: Using the GSPRM VFR charts.
VFR navigation plan
Airspace, communication, visual and radio-navigation data from VFR charts
Select routes taking the following criteria into account: classification of airspace; restricted areas; VFR semicircular rules; visually conspicuous points; radio-navigation aids.
Find the frequencies or identifiers of radio-navigation aids from charts.
Find the communication frequencies and call signs for the following: control agencies and service facilities; flight information service (FIS); weather information stations; automatic terminal information service (ATIS).
Planning courses, distances and cruising levels with VFR charts
Choose visual waypoints in accordance with specified criteria (large, unique, contrast, vertical extent, etc.).
Measure courses and distances from a VFR chart.
Find the highest obstacle within a given distance on either side of the course.
Find the following data from a VFR chart and transfer them to a navigation plan: waypoints or turning points; distances; true/magnetic courses.
Calculate the minimum pressure altitude with a given obstacle clearance or true altitude from a given altitude or pressure altitude from minimum grid-area altitude using outside air temperature (OAT) and QNH.
Calculate the vertical or horizontal distance and time to climb or descend to/from a given level or altitude with given data.
Explain how to determine the position of a significant VFR point for insertion into a global navigation satellite system (GNSS) flight plan, using the distance and bearing from an existing significant point and using coordinates.
Aerodrome charts and aerodrome directory
Explain the reasons for studying the visual departure procedures and the available approach procedures.
Find all visual procedures which can be expected at the departure, destination and alternate aerodromes.
Find all relevant aeronautical and regulatory information required for VFR flight planning from the aerodrome charts or aerodrome directory.
Completion of navigation plan
Calculate the true airspeed (TAS) from given aircraft performance data, altitude and OAT.
Calculate wind correction angles (WCAs), drift and ground speeds (GS).
Calculate individual and accumulated times for each leg to destination and alternate aerodromes.
FLIGHT PLANNING FOR IFR FLIGHTS. Remark: Using the GSPRM IFR charts.
IFR navigation plan
Air traffic service (ATS) routes
Identify suitable routings by identifying all relevant aeronautical and regulatory information (including information published in the national aeronautical information publication (AIP)) required for IFR flight planning.
Identify and describe ATS routes (conventional, area navigation (RNAV), required navigation performance (RNP), conditional routes (CDRs), and direct routes).
Courses and distances from en-route charts
Determine courses and distances.
Determine bearings and distances of waypoints from radio-navigation aids.
Altitudes

Define the following altitudes: minimum en-route altitude (MEA); minimum obstacle clearance altitude (MOCA); minimum sector altitude (MSA); minimum off-route altitude (MORA); grid minimum off-route altitude (Grid MORA); maximum authorised altitude (MAA); minimum crossing altitude (MCA); minimum holding altitude (MHA).
Extract the following altitudes from the chart(s): MEA; MOCA; MSA; MORA; Grid MORA; MAA; MCA; MHA.
State who is responsible for terrain separation during IFR flight inside and outside controlled airspace.
State the minimum obstacle clearance requirements for en-route IFR flight inside and outside controlled airspace.
State when a temperature error correction must be applied by either the pilot or ATC.
Identify and explain the use of minimum radar vectoring altitudes.
Calculate the minimum pressure altitude required with a given obstacle clearance, magnetic track, OAT, QNH and reduced vertical separation minimum (RVSM)/non-RVSM information.
Calculate true altitude above a given datum using a given pressure altitude, OAT and QNH.

Standard instrument departure (SID) and standard instrument arrival (STAR) routes

State the reasons for studying SID and STAR charts.
State that SID and STAR charts show procedures only in a pictorial presentation style which may not be true to scale.
Interpret all data and information represented on SID and STAR charts, particularly: routings; distances; courses; radials; altitudes/levels; frequencies; restrictions; RNAV waypoints and non-RNAV intersection; fly-over and fly-by waypoints.
Identify SID and STAR charts which might be relevant for a planned flight.
Define SID and STAR for RNAV only.
Describe the difference between SID/STAR, RNAV SID/STAR and RNAV SID/STAR overlay.

Instrument-approach charts

State the reasons for being familiar with instrument-approach procedures (IAPs) and appropriate data for departure, destination and alternate aerodromes.
Select IAPs appropriate for departure, destination and alternate aerodromes.
Interpret all procedures, data and information represented on instrument-approach charts, particularly: courses and radials; distances; altitudes/levels/heights; restrictions; obstructions; frequencies; speeds and times; decision altitudes/heights (DAs/Hs); (DA/H) and minimum descent altitudes/heights (MDAs/Hs); visibility and runway visual ranges (RVRs); approach-light systems.
Explain the following IAP terms: type A and B; 2D and 3D; CAT I, II and III; precision approach (conventional and ground-based augmentation system (GBAS)); non-precision approach (conventional and required navigation performance approach (RNP APCH) (lateral navigation (LNAV), LNAV/vertical navigation (VNAV), localiser performance (LP), localiser performance with vertical guidance (LPV), and required navigation performance authorisation required approach (RNP AR APCH)); approach procedure with vertical guidance (APV) (APV Baro and APV satellite-based augmentation system (SBAS)).

Communications and radio-navigation planning data

Find the communication frequencies and call signs for aeronautical services for IFR flights from en-route charts.
Find the frequency or identifiers of radio-navigation aids for IFR flights from en-route charts.

Completion of a manual navigation plan

Complete a navigation plan with the courses, distances and frequencies taken from charts.
Find the SID and STAR routes to be flown or to be expected.
Determine the position of top of climb (TOC) and top of descent (TOD) from given appropriate data.
Determine variation and calculate magnetic/true courses.
Calculate TAS from given aircraft performance data, altitude and OAT.
Calculate wind correction angles (WCAs)/drift and ground speeds (GSs).
Calculate individual and accumulated times for each leg to destination and alternate aerodromes.
Describe the advantages of global navigation satellite system/flight management computer (GNSS/FMC) equipment regarding: automatic calculation and display of tracks and leg distances; additional route information in the database (minimum altitudes, approach procedures); time and fuel estimates over waypoints; ability to adjust speed to arrive over a waypoint at a defined time; time and fuel revisions based on predicted and actual wind.
Describe the limitations of using GNSS/FMC equipment: pilot-inputted errors (flight levels, wind, temperature, fuel); the effect of other than predicted wind on fuel and time estimates; the effect of aircraft?s non-standard configuration on flight management system (FMS) predictions.

FUEL PLANNING — CAT.OP.MPA.106 and CAT.OP.MPA.150 plus AMC1, 2 and 3

General

Fuel planning (general)

Convert to volume, mass and density given in different units which are commonly used in aviation.
Determine relevant data, such as fuel capacity, fuel flow/ consumption at different power/thrust settings, altitudes and atmospheric conditions, from the flight manual.
Calculate the attainable flight time/range from given average fuel flow/consumption and available amount of fuel.

Calculate the required fuel from given average fuel flow/ consumption and required time/range to be flown.
Calculate the required fuel for a VFR or IFR flight from given forecast meteorological conditions.
State the minimum amount of remaining fuel required on arrival at the destination and alternate aerodromes/ heliports.
Explain and describe how to calculate nautical air miles (NAM) from nautical ground miles (NGM).

Pre-flight fuel planning for commercial flights

Taxi fuel

Determine the fuel required for engine start and taxiing by consulting the fuel-usage tables or graphs from the flight manual taking into account all the relevant conditions.

Trip fuel

Define trip fuel and name the segments of flight for which the trip fuel is relevant.
Determine the trip fuel for the flight by using data from the fuel tables or graphs from the flight manual.

Reserve fuel and its components

Contingency fuel

Explain the reasons for having contingency fuel.
Calculate the contingency fuel according to the applicable operational requirements.

Alternate fuel

Explain the reasons and regulations for having alternate fuel and name the segments of flight for which the alternate fuel is relevant.
Calculate the alternate fuel in accordance with the applicable operational requirements and relevant data from the navigation plan and the flight manual.

Final reserve fuel

Explain the reasons and regulations for having final reserve fuel.
Calculate the final reserve fuel for an aircraft in accordance with the applicable operational requirements and by using relevant data from the flight manual.

Additional fuel

Explain the reasons and regulations for having additional fuel.
Calculate the additional fuel for a flight in accordance with the applicable operational requirements.

Extra fuel

Explain the reasons and regulations for having extra fuel in accordance with the applicable operational requirements.
Calculate the possible extra fuel under given conditions.
Explain the fuel penalty incurred when loading extra fuel (i.e. the additional fuel consumption due to increased mass).

Calculation of total fuel and completion of the fuel section of the navigation plan (fuel plan)

Calculate the total fuel required for a given flight.
Complete the fuel plan.

Specific fuel-calculation procedures

Reduced contingency fuel procedure

Explain the reasons and regulations for reduced contingency fuel as stated in the applicable operational requirements.
Calculate the contingency fuel and trip fuel required in accordance with the reduced contingency fuel procedure.

Isolated aerodrome or heliport procedure

Explain the basic procedures for an isolated aerodrome or heliport as stated in the applicable operational requirements.
Calculate the additional fuel for aeroplanes or helicopters according to the isolated aerodrome or heliport procedures.

Predetermined-point procedure

Explain the basic idea of the predetermined-point procedure as stated in the applicable operational requirements.

Fuel-tankering

Explain the basic idea of fuel-tankering procedures.
Calculate how much fuel to tank by using given appropriate graphs, tables or data.

PRE-FLIGHT PREPARATION

Notice to airmen (NOTAM) briefing

Ground- and satellite-based facilities and services

Check that the ground- and satellite-based facilities and services required for the planned flight are available and adequate.

Departure, destination and alternate aerodromes

Find and analyse the latest state at the departure, destination and alternate aerodromes, in particular for: opening hours; work in progress (WIP); special procedures due to WIP; obstructions; changes of frequencies for communications, navigation aids and facilities.
Check that satellite-based facilities are available during the expected time of use.
Check that GBAS/SBAS augmentation is available during the expected time of use.
Airway routings and airspace structure
Find and analyse the latest en-route state for: airway(s) or route(s); restricted, danger and prohibited areas; changes of frequencies for communications, navigation aids and facilities.
Pre-flight preparation of GNSS achievability
Define why it is important to check GNSS achievability.
Define receiver autonomous integrity monitoring (RAIM), NOTAM and notice advisory to NavStar users (NANU) messages.
Explain the difference in use of augmented and non-augmented GNSS in connection with the achievability check.
Explain the difference in planned and unplanned outage of GNSS or SBAS.
Meteorological briefing
Update of navigation plan using the latest meteorological information
Confirm the most fuel-efficient altitude from given wind, temperature and aircraft data.
Confirm true altitudes from given atmospheric data to ensure that statutory minimum clearance is attained.
Confirm magnetic headings and GSs.
Confirm the individual leg times and the total time en route.
Confirm the total time en route for the trip to the destination.
Confirm the total time from destination to the alternate aerodrome.
Update of fuel plan
Calculate the revised fuel data in accordance with the changed conditions.
Point of equal time (PET) and point of safe return (PSR)
Point of equal time (PET)
Define 'PET'.
Calculate the position of a PET and the estimated time of arrival (ETA) at the PET from given relevant data.
Point of safe return (PSR)
Define 'PSR'.
Calculate the position of a PSR and the ETA at the PSR from given relevant data.
ICAO FLIGHT PLAN (ATS flight plan (FPL))
Individual FPL
Format of FPL
State the reasons for a fixed format of an ICAO ATS FPL.
Determine the correct entries to complete an ATS FPL plus decode and interpret the entries in a completed ATS FPL, particularly for the following: aircraft identification (Item 7); flight rules and type of flight (Item 8); number and type of aircraft and wake-turbulence category (Item 9); equipment (Item 10); departure aerodrome and time (Item 13); route (Item 15); destination aerodrome, total estimated elapsed time and alternate aerodrome (Item 16); other information (Item 18); supplementary information (Item 19).
Repetitive flight plan (RPL)
Repetitive flight plan (RPL)
Explain the difference between an individual FPL and an RPL.
FLIGHT MONITORING AND IN-FLIGHT REPLANNING
Flight monitoring
Monitoring of track and time
State the reasons for possible deviations from the planned track and planned timings.
Calculate GS by using actual in-flight parameters.
Calculate the expected leg times by using actual in-flight parameters.
Enter, in the progress of flight, at the checkpoint or turning point, the 'actual time-over' and the 'estimated time-over' for the next checkpoint into the flight plan.
State that it is necessary to determine the position of the aircraft accurately before commencing descent in order to ensure safe ground clearance.
Calculate revised ETA based on changes to the pre-flight plan, including changes of W/V, cruise level, OAT, distances, Mach number and calibrated airspeed (CAS).
In-flight fuel management
Explain why fuel checks must be carried out in flight at regular intervals and why relevant fuel data must be recorded.
Assess deviations of actual fuel consumption from planned consumption.
Calculate fuel quantity used, fuel consumption, and fuel remaining at navigation checkpoints/waypoints.

Compare the actual with the planned fuel consumption by means of calculation.
Determine the remaining range and endurance by means of calculation.
Calculate the revised fuel consumption based on changes to the pre-flight plan, including changes of W/V, cruise level, OAT, distances, Mach number and CAS.

In-flight replanning

Deviation from planned data

State that the commander is responsible for ensuring that, even in case of diversion, the remaining fuel is not less than the fuel required to proceed to an aerodrome where a safe landing can be made, with final reserve fuel remaining.
Explain that, in the case of an in-flight update, the commander has to check the following: the suitability of the new destination or alternate aerodrome; meteorological conditions on revised routing and at revised destination or alternate aerodrome; the aircraft must be able to land with the prescribed final reserve fuel.
Calculate the revised destination/alternate aerodrome landing mass from given latest data.

040. HUMAN PERFORMANCE AND LIMITATIONS

HUMAN FACTORS: BASIC CONCEPTS

Human factors in aviation

Becoming a competent pilot

State that competence is based on knowledge, skills and attitudes of the individual pilot, and list the ICAO eight core competencies: application of procedures; communication; aircraft flight path management, automation; aircraft flight path management, manual control; leadership and teamwork; problem-solving and decision-making; situation awareness; workload management.

Flight safety concepts

Threat and error management (TEM) model and SHELL model

Explain the three components of the TEM model.
Explain and give examples of latent threats.
Explain and give examples of environmental threats.
Explain and give examples of organisational threats.
Explain and give a definition of 'error' according to the TEM model of ICAO Doc 9683 (Part II, Chapter 2).
Give examples of different countermeasures which may be used in order to manage threats, errors, and undesired aircraft states.
Explain and give examples of procedural error, communication errors, and aircraft handling errors.
Explain and give examples of 'undesired aircraft states'.
State the components of the SHELL model.
State the relevance of the SHELL model to the work in the cockpit.

Safety culture

Safety culture and safety management

Distinguish between 'open cultures' and 'closed cultures'.
Illustrate how safety culture is reflected in national culture.
Discuss the established expression 'safety first' in a commercial entity.
Explain James Reason's 'Swiss Cheese Model'.
State the important factors that promote a good safety culture.
Distinguish between 'just culture' and 'non-punitive culture'.
Name the five components which form safety culture (according to James Reason: informed culture, reporting culture, learning culture, just culture, flexible culture).
Name the basic concepts of safety management system (SMS) (including hazard identification and risk management) and its relationship with safety culture in order to: define how the organisation is set up to manage risks; identify workplace risk and implement suitable controls; implement effective communication across all levels of the organisation.

BASICS OF AVIATION PHYSIOLOGY AND HEALTH MAINTENANCE

Basics of flight physiology

The atmosphere

State that the volume percentage of the gases in ambient air will remain constant at all altitudes at which conventional aircraft operate.

Respiratory and circulatory system

List the main components of the respiratory system and their function.
Identify the different volumes of air in the lungs and state the normal respiratory rate.
Explain the role of carbon dioxide in the control and regulation of respiration.
Describe the basic processes of external respiration and internal respiration.

List the factors that determine pulse rate.
Name the major components of the circulatory system and describe their function.
State the values for a normal pulse rate and the average cardiac output (heart rate × stroke volume) of an adult at rest.
Define 'systolic' and 'diastolic' blood pressure.
State the normal blood pressure ranges and units of measurement.
List the main constituents of blood and describe their functions.
Stress the function of haemoglobin in the circulatory system.
Define 'anaemia' and state its common causes.
Indicate the effect of increasing altitude on haemoglobin oxygen saturation.

Hypertension and hypotension

Define 'hypertension' and 'hypotension'.
List the effects that high and low blood pressure will have on some normal functions of the human body.
State that both hypotension and hypertension may disqualify a pilot from obtaining medical clearance to fly.
List the factors which can lead to hypertension for an individual.
State the corrective actions that may be taken to reduce high blood pressure.
Stress that hypertension is the major factor of strokes in the general population.

Coronary artery disease

Differentiate between 'angina' and 'heart attack'.
Explain the major risk factors for coronary disease.
State the role physical exercise plays in reducing the chances of developing coronary disease.

Hypoxia

Define the two major forms of hypoxia (hypoxic and anaemic), and the common causes of both.
State the symptoms of hypoxia.

State that healthy people are able to compensate for altitudes up to approximately 10 000–12 000 ft.
Name the three physiological thresholds and allocate the corresponding altitudes for each of them: reaction threshold (7 000 ft); disturbance threshold (10-12 000 ft); and critical threshold (22 000 ft).
State the altitude at which short-term memory begins to be affected by hypoxia.
Define the terms 'time of useful consciousness' (TUC) and 'effective performance time' (EPT).
State that TUC varies among individuals, but the approximate values for a person seated (at rest) are: 20 000 ft 30 min; 30 000 ft 1-2 min; 35 000 ft 30-90 s; 40 000 ft 15-20 s.
List the factors that determine the severity of hypoxia.
State the equivalent altitudes when breathing ambient air and 100 % oxygen at mean sea level (MSL) and at approximately 10 000, 30 000 and 40 000 ft.

Hyperventilation

Describe the role of carbon dioxide in hyperventilation.
Define the term 'hyperventilation'.
List the factors that cause hyperventilation.
State that hyperventilation may be caused by psychological or physiological reasons.
List the signs and symptoms of hyperventilation.
List the measures which may be taken to counteract hyperventilation: breath slowly, close one opening of the nose, speak loudly, place a paper bag over nose and mouth.

Decompression sickness/illness

State the normal range of cabin pressure altitude in pressurised commercial air transport aircraft and describe its protective function for aircrew and passengers.
List the vital actions the crew has to perform when cabin pressurisation is lost (oxygen mask on, emergency descent, land as soon as possible, and no further flight for the next minimum 24 hours). State that decompression sickness symptoms can occur up to 24 hours later.
Identify the causes of decompression sickness in flight operation.
State how decompression sickness can be prevented.
List the symptoms of decompression sickness (bends, creeps, chokes, staggers).
Indicate how decompression sickness may be treated.
Define the hazards of diving and flying, and give the recommendations associated with these activities.

Acceleration

Define 'linear acceleration' and 'angular acceleration'.
Describe the effects of z-acceleration on the circulation and blood volume distribution.
List magnitude, duration and onset as factors that determine the effects of acceleration on the human body.
List the effects of positive acceleration with respect to type, sequence and corresponding G-load.

Carbon monoxide
State how carbon monoxide is produced.
State how the presence of carbon monoxide in the blood affects the distribution of oxygen.
List the signs and symptoms of carbon-monoxide poisoning.
Explain immediate countermeasures on suspicion of carbon-monoxide poisoning and how poisoning can be treated later on the ground.
High-altitude environment
State how an increase in altitude may change the proportion of ozone in the atmosphere and that aircraft can be equipped with special ozone removers.
Radiation
State the sources of radiation at high altitude.
List the effects of excessive exposure to radiation.
Humidity
List the factors that affect the relative humidity of both the atmosphere and cabin air.
List the effects of low humidity on human body to be spurious thirst, dry eyes, skin and mucous membranes, and indicate measures that can be taken: drinking water, using eye drops and aqueous creams.
People and the environment: the sensory system
The different senses
List the different senses.

Central, peripheral and autonomic nervous system
Define the term 'sensory threshold'.
Define the term 'sensitivity', especially in the context of vision.
Give examples of sensory adaptation.
Define the term 'habituation' and state its implication for flight safety.
Vision
Functional anatomy
Name the most important parts of the eye and the pathway to the visual cortex.
State the basic functions of the parts of the eye.
Define 'accommodation'.
Distinguish between the functions of the rod and cone cells.
Describe the distribution of rod and cone cells in the retina and explain their relevance to vision.
The fovea (fovea centralis) and peripheral vision
Explain the terms 'visual acuity', 'visual field', 'central vision', 'peripheral vision' and 'the fovea', and explain their function in the process of vision.
List the factors that may degrade visual acuity and the importance of 'lookout'.
State the limitations of night vision and the different scanning techniques at both night and day.
State the time necessary for the eye to adapt to bright light and the dark.
State the effect of hypoxia, smoking and altitude in excess of 5 000 ft on night vision.
Explain the nature of colour blindness.
Binocular and monocular vision
Distinguish between monocular and binocular vision.
Explain the basis of depth perception and its relevance to flight performance.
List the possible monocular cues for depth perception.
State that for high-energy blue light and UV rays, sunglasses can prevent damage to the retina.
Defective vision
Explain long-sightedness, short-sightedness and astigmatism.
List the causes of and the precautions that may be taken to reduce the probability of vision loss due to: presbyopia; cataract; glaucoma.
List the types of sunglasses that could cause perceptional problems in flight.
List the measures that may be taken to protect oneself from flash blindness.
State the possible problems associated with contact lenses.
State the current rules/regulations governing the wearing of corrective spectacles and contact lenses when operating as a pilot.
Explain the significance of the 'blind spot' on the retina in detecting other traffic in flight.
Hearing
Descriptive and functional anatomy
State the basic parts and functions of the outer, the middle and the inner ear.
Differentiate between the functions of the vestibular apparatus and the cochlea in the inner ear.
Hearing loss

Define the main causes of the following hearing defects/loss: 'conductive deafness'; 'noise-induced hearing loss' (NIHL); 'presbycusis'.
Summarise the effects of environmental noise on hearing.
State the decibel level of received noise that will cause NIHL.
Identify the potential occupational risks that may cause hearing loss.
List the main sources of hearing loss in the flying environment.
List the precautions that may be taken to reduce the probability of onset of hearing loss.

Equilibrium

Functional anatomy

List the main elements of the vestibular apparatus.
State the functions of the vestibular apparatus on the ground and in flight.
Distinguish between the component parts of the vestibular apparatus in the detection of linear and angular acceleration as well as on gravity.
Explain how the semicircular canals are stimulated.

Motion sickness

Describe air sickness and its accompanying symptoms.
List the causes of air sickness.
Describe the necessary actions to be taken to counteract the symptoms of air sickness.

Integration of sensory inputs

State the interaction between vision, equilibrium, proprioception and hearing to obtain spatial orientation in flight.
Define the term 'illusion'.
Give examples of visual illusions based on shape constancy, size constancy, aerial perspective, atmospheric perspective, the absence of focal or ambient cues, autokinesis, vectional false horizons, field myopia, and surface planes.
Relate these illusions to problems that may be experienced in flight and identify the danger attached to them.
List approach and landing illusions for slope of the runway, black-hole approach, and terrain around runway, and state the danger involved with recommendations to avoid or counteract the problems with high or low approach or flare at the wrong time.
State the problems associated with flickering lights (strobe lights, anti-collision lights, propellers and rotors under certain light conditions, etc.).
Describe vestibular illusions caused by the angular accelerations (the Leans, Coriolis) and linear accelerations (somatogravic, G-effect).
Relate the above-mentioned vestibular illusions to problems encountered in flight and state the dangers involved.
State that the 'seat-of-the-pants' sense is completely unreliable when visual contact with the ground is lost or when flying in instrument meteorological conditions (IMC) or with a poor visual horizon.
Differentiate between vertigo, Coriolis effect, and spatial disorientation.
List the measures to prevent or overcome spatial disorientation.

Health and hygiene

Body rhythm and sleep

Name some internal body rhythms and their relevance to sleep. Explain that the most important of which is body temperature.
Explain the term 'circadian rhythm'.
State the approximate duration of a 'free-running' rhythm.
Explain the significance of the 'internal clock' in regulating the normal circadian rhythm.
State the effect of the circadian rhythm of body temperature on an individual's performance standard and on an individual's sleep patterns.
List and describe the stages of a sleep cycle.
Differentiate between rapid eye movement (REM) and non-REM sleep.
Explain the function of sleep and describe the effects of insufficient sleep on performance.
Explain the simple calculations for the sleep/wake credit/debit situation.
Explain how sleep debit can become cumulative.
State the time formula for the adjustment of body rhythms to the new local time scale after crossing time zones.
State the problems caused by circadian disrhythmia (jet lag) with regard to an individual's performance and sleep.
Differentiate between the effects of westbound and eastbound travel.
Explain the interactive effects of circadian rhythm and vigilance on a pilot's performance during flight as the duty day elapses.
Describe the main effects of lack of sleep on an individual's performance.
List the possible strategies to cope with jet lag.

Problem areas for pilots

Common minor ailments
State the role of the Eustachian tube in equalising pressure between the middle ear and the environment.
State that the in-flight environment may increase the severity of symptoms which may be minor while on the ground.
List the negative effects of suffering from colds or flu on flight operations especially with regard to the middle ear, the sinuses, and the teeth.
State when a pilot should seek medical advice from an aeromedical examiner (AME) or aeromedical centre (AeMC).
Describe the measures to prevent or clear problems due to pressure changes during flight.
Entrapped gases and barotrauma
Define 'barotrauma'.
Differentiate between otic, sinus, gastrointestinal and aerodontalgia (of the teeth) barotraumas and explain avoidance strategies.
Explain why the effects of otic barotrauma can be worse in the descent.
Gastrointestinal upsets
State the effects of gastrointestinal upsets that may occur during flight.
List the precautions that should be observed to reduce the occurrence of gastrointestinal upsets.
Indicate the major sources of gastrointestinal upsets.
Obesity
Define 'obesity'.
State the following harmful effects obesity can cause: possibility of developing coronary problems; increased chances of developing diabetes; reduced ability to withstand G-forces; development of problems with the joints of the limbs; general circulatory problems; reduced ability to cope with hypoxia or decompression sickness; sleep apnoea.
Describe the problems associated with Type 2 (mostly adult) diabetes: risk factors; insulin resistance; complications (vascular, neurological) and the consequences for the medical licence; pilots are not protected from Type 2 diabetes more than other people.
Describe the typical back problems (unspecific back pain, slipped disc) that pilots have. Explain also the ways of preventing and treating these problems: good sitting posture; lumbar support; good physical condition; in-flight exercise, if possible; physiotherapy.
Food hygiene
Stress the importance of and methods to be adopted by aircrew, especially when travelling abroad, to avoid contaminated food and liquids.
List the major contaminating sources in foodstuffs.
State the major constituents of a healthy diet.
State the measure to avoid hypoglycaemia.
State the importance of adequate hydration.
Tropical climates
List the problems associated with operating in tropical climates.
State the possible causes/sources of incapacitation in tropical countries with reference to: standards of hygiene; quality of water supply; insect borne diseases; parasitic worms; rabies or other diseases that may be spread through contact with animals; sexually transmitted diseases.
State the precautions to be taken to reduce the risks of developing problems in tropical areas.
Infectious diseases
State the major infectious diseases that may severely incapacitate or kill individuals.
State the precautions that must be taken to ensure that disease-carrying insects are not transported between areas.
Intoxication
Tobacco
State the harmful effects of tobacco on: the respiratory system; the cardiovascular system; the ability to resist hypoxia; the ability to withstand G-forces; night vision.
Caffeine
Indicate the level of caffeine dosage at which performance is degraded.
Besides coffee, indicate other beverages containing caffeine.
Alcohol
State the maximum acceptable limit of alcohol for flight crew according to the applicable regulations.
State the effects of alcohol consumption on: the ability to reason; inhibitions and self-control; vision; the sense of balance and sensory illusions; sleep patterns; hypoxia.
State the effects alcohol may have if consumed together with other drugs.
List the signs and symptoms of alcoholism.
List the factors that may be associated with the development of alcoholism.

Define the 'unit' of alcohol and state the approximate elimination rate from the blood.
State the maximum daily and weekly intake of units of alcohol which may be consumed without causing damage to the organs and systems of the human body.
Discuss the actions that might be taken if a crew member is suspected of being an alcoholic.

Prescription and non-prescription drugs and self-medication

State the dangers associated with the use of non-prescription drugs.
State the side effects of common non-prescription drugs used to treat colds, flu, hay fever and other allergies, especially medicines containing antihistamine preparations.
Interpret the rules relevant to using (prescription or non-prescription) drugs that the pilot has not used before.
Interpret the general rule that 'if a pilot is so unwell that they require any medication, then they should consider themselves unfit to fly'.

Toxic materials

List those materials present in an aircraft which may, when uncontained, cause severe health problems.
List those aircraft-component parts which if burnt may give off toxic fumes.
Describe a fume event and the possible incapacitating effects on those exposed to it.

Incapacitation in flight

State that incapacitation is most dangerous when its onset is insidious.
List the major causes of in-flight incapacitation.
State the importance of crew to be able to recognise and promptly react upon incapacitation of other crew members, should it occur in flight.
Explain methods and procedures to cope with incapacitation in flight.

BASIC AVIATION PSYCHOLOGY

Human information processing

Attention and vigilance

Differentiate between 'attention' and 'vigilance'.
Differentiate between 'selective' and 'divided' attention.
Define 'hypovigilance'.
Identify the factors that may affect the state of vigilance.
List the factors that may forestall hypovigilance during flight.
Indicate the signs of reduced vigilance.
List the factors that affect a person's level of attention.

Perception

Name the basis of the perceptual process.
Describe the mechanism of perception ('bottom-up'/'top-down' process).
Illustrate why perception is subjective and state the relevant factors that influence interpretation of perceived information.
Describe some basic perceptual illusions.
Illustrate some basic perceptual concepts.
Give examples where perception plays a decisive role in flight safety.
Stress how persuasive and believable mistaken perception can manifest itself both for an individual and a group.

Memory

Explain the link between the types of memory (to include sensory, working/short-term and long-term memory).
Describe the differences between the types of memory in terms of capacity and retention time.
Justify the importance of sensory-store memories in processing information.
State the average maximum number of separate items that may be held in working memory (5 plus/minus 2).
Stress how interruption can affect short-term/working memory.
Give examples of items that are important for pilots to hold in working memory during flight.
Describe how the capacity of the working-memory store may be increased.
State the subdivisions of long-term memory and give examples of their content.
Explain that skills are kept primarily in the long-term memory.
Describe amnesia and how it affects memory.
Name the common problems with both the long- and short-term memories and the best methods to try to counteract them.

Response selection

Learning principles and techniques

Explain and distinguish between the following basic forms of learning: classic and operant conditioning (behaviouristic approach); learning by insight (cognitive approach); learning by imitating (modelling).
Recognise pilot-related examples as behaviouristic, cognitive or modelling forms of learning.
State the factors that are necessary for and promote the quality of learning: intrinsic motivation; good mental health; rehearsals for improvement of memory; consciousness; vigilance; application in practical exercises.

Explain ways to facilitate the memorisation of information with the following learning techniques: mnemonics; mental training.
Describe the advantage of planning and anticipation of future actions: define the term 'skills'; state the three phases of learning a skill (Anderson: cognitive, associative and autonomous phase).
Explain the term 'motor programme' or 'mental schema'.
Describe the advantages and disadvantages of mental schemas.
Explain the Rasmussen model which describes the guidance of a pilot's behaviour in different situations.
State the possible problems or risks associated with skill-, rule- and knowledge-based behaviour.

Motivation

Define 'motivation'.
Explain the relationship between motivation and learning.
Explain the problems of over-motivation, especially in the context of the extreme need to achieve.

Human error and reliability

Reliability of human behaviour

Name and explain the factors that influence human reliability.

Mental models and situation awareness

Define the term 'situation awareness'.
List the cues that indicate loss of situation awareness and name the steps to regain it.
List the factors that influence one's situation awareness both positively and negatively, and stress the importance of situation awareness in the context of flight safety.
Define the term 'mental model' in relation to a surrounding complex situation.
Describe the advantages/disadvantages of mental models.
Explain the relationship between personal 'mental models' and the creation of cognitive illusions.

Theory and model of human error

Explain the concept of the 'error chain'.
Differentiate between an isolated error and an error chain.
Distinguish between the main forms/types of errors (i.e. slips, faults, omissions and violations).
Discuss the above errors and their relevance in flight.
Distinguish between an active and a latent error, and give examples.

Error generation

Distinguish between internal and external factors in error generation.
Identify possible sources of internal error generation.
Define and discuss the two errors associated with motor programmes (action slip and environmental capture).
List the three main sources of external error generation in the flight crew compartment.
Give examples to illustrate the following factors in external error generation in the flight crew compartment: ergonomics; economics; social environment.
Name the major goals in the design of human-centred human–machine interfaces.
Define the term 'error tolerance'.
List and describe the strategies that are used to reduce human error.
Describe the advantage of planning and the anticipation of future actions.

Decision-making

Decision-making concepts

Define the terms 'deciding' and 'decision-making'.
Describe the major factors on which decision-making should be based during the course of a flight.
Describe the main human attributes with regard to decision-making.
Discuss the nature of bias and its influence on the decision-making process.
Describe the main error sources and limits in an individual's decision-making mechanism.
State the factors upon which an individual's risk assessment is based.
Explain the relationship between risk assessment, commitment and pressure of time in decision-making strategies.
Explain the risks associated with dispersion or channelised attention during the application of procedures requiring a high workload within a short time frame (e.g. a go-around).
Describe the positive and negative influences exerted by other group members on an individual's decision-making process (risky shift).
Explain the general idea behind the creation of a model for decision-making based upon: definition of the aim; collection of information; risk assessment; development of options; evaluation of options; decision; implementation; consequences; review and feedback.

Avoiding and managing errors: cockpit management

Safety awareness

Justify the need for being aware of not only one's own performance but that of others before and during a flight and the possible consequences or risks.

Coordination (multi-crew concepts)
Name the objectives of the multi-crew concept.
State and explain the elements of multi-crew concepts.
Describe the concepts of 'standard operating procedures' (SOPs), checklists and crew briefings.
Describe the purpose of and procedure for crew briefings.
Describe the purpose of and procedure for checklists.
Describe the function of communication in a coordinated team.
Explain the advantages of SOPs.
Explain how SOPs contribute to avoiding, reducing and managing threats and errors.
Explain potential threats of SOPs, for example during company or type conversion (e.g. motor programmes, company culture, hazardous attitudes, developed habits).
Cooperation
Distinguish between cooperation and coaction.
Define the term 'group'.
Illustrate the influence of interdependence in a group.
List the advantages and disadvantages of teamwork.
Explain the term 'synergy'.
Define the term 'cohesion'.
Define the term 'groupthink'.
State the essential conditions for good teamwork.
Explain the function of role and norm in a group.
Name the different role patterns which occur in a group situation.
Explain how behaviour can be affected by the following factors: persuasion; conformity; compliance; obedience.
Distinguish between status and role.
Stress the inherent dangers of a situation where there is a mix of role and status within the flight crew compartment.
Explain the terms 'leadership' and 'followership'.
Describe the trans-cockpit authority gradient and its affiliated leadership styles (i.e. autocratic, laissez-faire and synergistic).
Name the most important attributes of a positive leadership style.
Communication
Define the term 'communication'.
List the most basic components of interpersonal communication.
Explain the advantages of in-person two-way communication as opposed to one-way communication.
Name the importance of non-verbal communication.
Describe the general aspects of non-verbal communication.
Describe the advantages/disadvantages of implicit and explicit communication.
Describe the advantages and possible problems of using 'social' and 'professional' language in high- and low-workload situations.
Name and explain the major obstacles to effective communication.
Explain the difference between intrapersonal and interpersonal conflict.
Describe the escalation process in human conflict.
List the typical consequences of conflicts between crew members.
Explain the following terms as part of the communication practice with regard to preventing or resolving conflicts: inquiry; active listening; advocacy; feedback; metacommunication; negotiation.
Describe the limitations of communication in situations of high workload in the flight crew compartment in view of listening, verbal, non-verbal and visual effects.
Human behaviour
Personality, attitude and behaviour
Describe the factors that determine an individual's behaviour.
Define and distinguish between 'personality', 'attitude' and 'behaviour'.
State the origin of personality and attitude.
State that with behaviour good and bad habits can be formed.
Explain how behaviour is generally a product of personality, attitude and the environment to which one was exposed at significant moments (childhood, schooling and training).
State that personality differences and selfish attitude may have effects on flight crew performance.
Individual differences in personality and motivation
Describe the individual differences in personality by means of a common trait model (e.g. Eysenck's personality factors) and use it to describe today's ideal pilot.
Self-concept

Define the term 'self-concept' and the role it plays in any change of personality.
Explain how a self-concept of underconfidence may lead to an outward show of aggression and self- assertiveness.
Self-discipline
Define 'self-discipline' and justify its importance for flight safety.
Identification of hazardous attitudes (error proneness)
Explain dangerous attitudes in aviation: anti-authority; macho; impulsivity; invulnerability; complacency; resignation.
Describe the personality, attitude and behaviour patterns of an ideal crew member.
Summarise how a person's attitude influences their work in the flight crew compartment.
Human overload and underload
Arousal
Explain the term 'arousal'.
Describe the relationship between arousal and performance.
Explain the circumstances under which underload may occur and its possible dangers.
Stress
Explain the term 'stress' and why stress is a natural human reaction.
State that the physiological response to stress is generated by the 'fight or flight' response.
Describe the function of the autonomic nervous system (ANS) in stress response.
Explain the relationship between arousal and stress.
State the relationship between stress and performance.
State the basic categories of stressors.
List and discuss the major environmental sources of stress in the flight crew compartment.
Discuss the concept of 'break point' with regard to stress, overload and performance.
Name the principal causes of domestic stress.
State that the stress experienced as a result of particular demands varies among individuals.
Explain the factors that lead to differences in the levels of stress experienced by individuals.
List the factors that influence the tolerance of stressors.
State that stress is a result of perceived demands and perceived ability.
Explain the relationship between stress and anxiety.
Describe the effects of anxiety on human performance.
State the general effect of acute stress on people.
Describe the relationship between stress, arousal and vigilance.
State the general effect of chronic stress and the biological reaction by means of the three stages of the general adaptation syndrome (Selye): alarm, resistance, and exhaustion.
Explain the differences between psychological, psychosomatic and somatic stress reactions.
Name the typical common physiological and psychological symptoms of human overload.
Describe the effects of stress on human behaviour.
Explain how stress is cumulative and how stress from one situation can be transferred to a different situation.
Explain how successful completion of a stressful task will reduce the amount of stress experienced when a similar situation arises in the future.
Describe the effect of human underload/overload on effectiveness in the flight crew compartment.
List sources and symptoms of human underload.
Fatigue and stress management
Explain the term 'fatigue' and differentiate between the two types of fatigue (short-term and chronic fatigue).
Name the causes of short-term and chronic fatigue.
Identify the symptoms and describe the effects of fatigue.
List the strategies that prevent or delay the onset of fatigue and hypovigilance.
List and describe strategies for coping with stress factors and stress reactions.
Distinguish between short-term and long-term methods of stress management.
Give examples of short-term methods of stress management.
Give examples of long-term methods of coping with stress.
Describe the fatique risk management system (FRMS) as follows: a data-driven means of continuously monitoring and managing fatigue-related safety risks, based upon scientific principles and knowledge as well as operational experience that aims to ensure relevant personnel are performing at adequate levels of alertness.
Advanced cockpit automation
Advantages and disadvantages
Compare the two basic concepts of automation: as per Boeing, where the pilot remains the last operator; and as per Airbus, where automated systems can correct erroneous pilot action.
Explain the fundamental restrictions of autoflight systems to be lack of creativity in unknown situations, and lack of personal motivation with regard to safety.

List the principal strengths and weaknesses of pilot versus autopilot systems to be creativity, decision-making, prioritisation of tasks, safety attitude versus precision, reliability.
Explain the 'ironies of automation': designers' errors due to wrong interpretation of the data, leaving tasks to the pilot that are too complex to automate, loss of manual and cognitive skills of the pilot. State the necessity for regular training flights as one possible countermeasure.
Describe methods to overcome the drawbacks of autoflight systems to be loss of manual flying capabilities, additional workload through programming, risk of slips during programming, and hypovigilance during cruise.
Automation complacency
State the main weaknesses in the monitoring of automatic systems to be hypovigilance during flight, and loss of flying skills.
Explain some basic flight crew errors and terms that arise with the introduction of automation: passive monitoring; blinkered concentration; confusion; mode awareness.
Explain how the method of call-outs counteracts ineffective monitoring of automatic systems.
Define 'complacency'.
Working concepts
Explain that the potential disadvantages of automation on crew communication are loss of awareness of input errors, flight modes, failure detection, failure comprehension, status of the aircraft and aircraft position.
Explain how the negative effects of automation on pilots may be alleviated by degrading to a lower level of automation to recover comprehension of the flight status from VNAV/LNAV to ALT/HDG or even to manual flying.
Interpret the role of automation with respect to flight safety regarding the basic principle of the use of manual versus autoflight in normal operations, frequent changes in the flight profile, and in abnormal situations.

050. METEOROLOGY

THE ATMOSPHERE
Composition, extent, vertical division
Structure of the atmosphere
Describe the vertical division of the atmosphere up to flight level (FL) 650, based on the temperature variations with height.
List the different layers and their main qualitative characteristics up to FL 650.
Troposphere
Describe the troposphere.
Describe the main characteristics of the tropopause.
Describe the proportions of the most important gases in the air in the troposphere.
Describe the variations of the FL and temperature of the tropopause from the poles to the equator.
Describe the breaks in the tropopause along the boundaries of the main air masses.
Indicate the variations of the FL of the tropopause with the seasons and the variations of atmospheric pressure.
Stratosphere
Describe the stratosphere up to FL 650.
Describe that ozone can occur at jet cruise altitudes and that it constitutes a hazard.
Air temperature
Definition and units
Define 'air temperature'.
List the units of measurement of air temperature used in aviation meteorology (Celsius, Fahrenheit, Kelvin). (Refer to Subject 050 10 01 01)
Vertical distribution of temperature
Describe the mean vertical distribution of temperature up to FL 650.
Mention the general causes of the cooling of the air in the troposphere with increasing altitude.
Calculate the temperature and temperature deviations (in relation to International Standard Atmosphere (ISA)) at specified levels.
Transfer of heat
Explain how local cooling or warming processes result in transfer of heat.
Describe radiation.
Describe solar radiation reaching the Earth.
Describe the filtering effect of the atmosphere on solar radiation.
Describe terrestrial radiation.
Explain how terrestrial radiation is absorbed by some components of the atmosphere.
Explain the effect of absorption and radiation in connection with clouds.
Explain the process of conduction.
Explain the role of conduction in the cooling and warming of the atmosphere.

Explain the process of convection.
Name the situations in which convection occurs.
Explain the process of advection.
Name the situations in which advection occurs.
Describe the transfer of heat by turbulence.
Describe the transfer of latent heat.

Lapse rates

Describe qualitatively and quantitatively the temperature lapse rates of the troposphere (mean value 0.65 deg C/100 m or 2 deg C/1 000 ft and actual values).

Development of inversions, types of inversions

Describe the development and types of inversions.
Explain the characteristics of inversions and of an isothermal layer concerning stability and vertical motions.
Explain the reasons for the formation of the following inversions: ground inversion (nocturnal radiation/advection), subsidence inversion, frontal inversion, inversion above friction layer, valley inversion.

Temperature near the Earth's surface, insolation, surface effects, effect of clouds, effect of wind

Explain the cooling/warming of the surface of the Earth by radiation.
Explain the cooling/warming of the air by molecular or turbulent heat transfer to/from the earth or sea surfaces.
Describe qualitatively the influence of the clouds on the cooling and warming of the surface and the air near the surface.
Explain the influence of the wind on the cooling and warming of the air near the surfaces.

Atmospheric pressure

Barometric pressure, isobars

Define 'atmospheric pressure'.
List the units of measurement of the atmospheric pressure used in aviation (hPa, inches of mercury).
(Refer to Subject 050 10 01 01)
Describe the principle of the barometers (mercury barometer, aneroid barometer).
Define isobars and identify them on surface weather charts.
Define 'high', 'low', 'trough', 'ridge', 'col'.

Pressure variation with height, contours (isohypses)

Explain the pressure variation with height.
Describe quantitatively the variation of the barometric lapse rate. Remark: An approximation of the average value for the barometric lapse rate near mean sea level (MSL) is 30 ft (9 m) per 1 hPa.
State that (under conditions of ISA) pressure is approximately 50 per cent of MSL at 18 000 ft and density is approximately 50 per cent of MSL at 22 000 ft and 25 per cent of MSL at 40 000 ft.

Reduction of pressure to QFF (MSL)

Define 'QFF'.
Explain the reduction of measured pressure (QFE) to QFF (MSL).
Mention the use of QFF for surface weather charts.

Relationship between surface pressure centres and pressure centres aloft

Illustrate with a vertical cross section of isobaric surfaces the relationship between surface pressure systems and upper-air pressure systems.

Air density

Relationship between pressure, temperature and density

Describe the relationship between pressure, temperature and density.
Describe the vertical variation of the air density in the atmosphere.

International Standard Atmosphere (ISA)

International Standard Atmosphere (ISA)

Explain the use of standardised values for the atmosphere.
List the main values of the ISA MSL pressure, MSL temperature, the vertical temperature lapse rate up to FL 650, height and temperature of the tropopause.

Altimetry

Terminology and definitions

Define the following terms and explain how they are related to each other: height, altitude, pressure altitude, FL, pressure level, true altitude, true height, elevation, QNH, QFE, and standard altimeter setting.
Describe the terms 'transition altitude', 'transition level', 'transition layer', 'terrain clearance', 'lowest usable flight level'.

Altimeter settings

Name the altimeter settings associated to height, altitude, pressure altitude and FL.
Describe the altimeter-setting procedures.

Calculations

Calculate the different readings on the altimeter when the pilot uses different settings (QNH, 1013.25, QFE).
Illustrate with a numbered example the changes of altimeter setting and the associated changes in reading when the pilot climbs through the transition altitude or descends through the transition level.
Derive the reading of the altimeter of an aircraft on the ground when the pilot uses the different settings.
Explain the influence of the air temperature on the distance between the ground and the level read on the altimeter and between two FLs.
Explain the influence of pressure areas on true altitude.
Determine the true altitude/height for a given altitude/height and a given ISA temperature deviation.
Calculate the terrain clearance and the lowest usable FL for given atmospheric temperature and pressure conditions.
State that the 4 per cent-rule can be used to calculate true altitude from indicated altitude, and also indicated altitude from true altitude (not precise but sufficient due to the approximation of the 4 per cent-rule.)
Remark: The following rules should be considered for altimetry **c**alculations:
a. All calculations are based on rounded pressure values to the nearest lower hPa.
b. The value for the barometric lapse rate between MSL and 700 hPa to be used is 30 ft/hPa as an acceptable approximation of the barometric lapse rate.
c. To determine the true altitude/height, the following rule of thumb, called the '4 per cent-rule', shall be used: the altitude/height changes by 4 per cent for each 10 deg C temperature deviation from ISA.
d. If no further information is given, the deviation of the outside-air temperature from ISA is considered to be constantly the same given value in the whole layer.
e. The elevation of the aerodrome has to be taken into account. The temperature correction has to be considered for the layer between the ground and the position of the aircraft.
Effect of accelerated airflow due to topography
Describe qualitatively how the effect of accelerated airflow due to topography (the Bernoulli effect) affects altimetry.
WIND
Definition and measurement of wind
Definition and measurement
Define 'wind' and 'surface wind'.
State the units of wind directions (degrees true in reports; degrees magnetic from tower) and speed (kt, m/s).

Describe that the reported wind is an average wind derived from measurements with an anemometer at a height of 10 m over 2 min for local routine and special reports and ATS units, and over 10 min for aerodrome routine meteorological reports (METARs) and aerodrome special meteorological reports (SPECIs).
Primary cause of wind
Primary cause of wind, pressure gradient, Coriolis force, gradient wind
Define the term 'horizontal pressure gradient'.
Explain how the pressure gradient force acts in relation to the pressure gradient.
Explain how the Coriolis force acts in relation to the wind.
Explain the development of the geostrophic wind.
Indicate how the geostrophic wind flows in relation to the isobars/isohypses in the northern and in the southern hemisphere.
Analyse the effect of changing latitude on the geostrophic wind speed.
Explain the gradient wind effect and indicate how the gradient wind differs from the geostrophic wind in cyclonic and anticyclonic circulation.
Variation of wind in the friction layer
Describe why and how the wind changes direction and speed with height in the friction layer in the northern and in the southern hemisphere (rule of thumb).
State the surface and air-mass conditions that influence the wind in the friction layer (diurnal variation).
Name terrain, wind speed and stability as the main factors that influence the vertical extent of the friction layer.
Explain the relationship between isobars and wind (direction and speed). Remarks: approximate value for variation of wind in the friction layer (values to be used in examinations): Type of landscape; wind speed in friction layer in per cent of the geostrophic wind; the wind in the friction layer blows across the isobars towards the low pressure, angle between wind direction and isobars. Over water; ca 70 per cent; ca 10 deg. Over land; ca 50 per cent; ca 30 deg. WMO No. 266.
Effects of convergence and divergence
Describe atmospheric convergence and divergence.
Explain the relationship between convergence and divergence on the following: pressure systems at the surface and aloft; wind speed; vertical motion and cloud formation (relationship between upper-air conditions and surface pressure systems).

General global circulation

General circulation around the globe

Describe the general global circulation.

(Refer to Subject 050 08 01 01)

Name and sketch or indicate on a map the global distribution of the surface pressure and the resulting wind pattern for all latitudes at low level in January and July.

Sketch or indicate on a map the westerly and easterly tropospheric winds at high level in January and July.

Local winds

Anabatic and katabatic winds, mountain and valley winds, Venturi effects, land and sea breezes

Describe and explain anabatic and katabatic winds.

Describe mountain and valley winds.

Describe the Venturi effect, convergence in valleys and mountain areas.

Describe land and sea breezes, and sea-breeze front.

Describe that local, low-level jet streams can develop in the evening.

Mountain waves (standing waves, lee waves)

Origin and characteristics

Explain the origin and formation of mountain waves.

State the conditions necessary for the formation of mountain waves.

Describe the structure and properties of mountain waves.

Explain how mountain waves may be identified by their associated meteorological phenomena.

Describe that mountain wave effects can exceed the performance or structural capability of aircraft.

Describe that mountain wave effects can propagate from low to high level, e.g. over Greenland and elsewhere.

Turbulence

Description and types of turbulence

Describe turbulence and gustiness.

List the common types of turbulence (convective, mechanical, orographic, frontal, clear-air turbulence).

Formation and location of turbulence

Explain the formation of convective turbulence, mechanical and orographic turbulence, and frontal turbulence.

State where turbulence will normally be found (rough-ground surfaces, relief, inversion layers, cumulonimbus (CB), thunderstorm (TS) zones, unstable layers).

Clear-air turbulence (CAT) — description, cause and location

Describe CAT.

Describe the formation of CAT.

State where CAT is found in association with jet streams, in high-level troughs and in other disturbed high-level air flows.

(Refer to Subject 050 09 02 02)

State that remote sensing of CAT from satellites is not possible and that forecasting is limited.

State that pilot reports of turbulence are a very valuable source of information as remote measurements are not available.

Jet streams

Description

Describe jet streams.

State the defined minimum speed of a jet stream (60 kt).

State the typical figures for the dimensions of jet streams.

Formation and properties of jet streams

Explain the formation and state the heights, the speeds, the seasonal variations of speeds, the geographical positions, the seasonal occurrence and the seasonal movements of the arctic (front) jet stream, the polar (front) jet stream, the subtropical jet stream, and the tropical (easterly/equatorial) jet stream.

Location of jet streams and associated CAT areas

Sketch or describe where polar front and arctic jet streams are found in the troposphere in relation to the tropopause and to fronts.

Describe and indicate the areas of worst wind shear and CAT.

THERMODYNAMICS

Humidity

Water vapour in the atmosphere

State that the density of moist air is less than the density of dry air.

Describe the significance for meteorology of water vapour in the atmosphere.

Indicate the sources of atmospheric humidity.

Define ‘saturation of air by water vapour’.

Temperature/dew point, relative humidity

Define ‘dew point’.
Define ‘relative humidity’.
Explain the factors that influence the relative humidity at constant pressure.
Explain the diurnal variation of the relative humidity.
Describe the relationship between temperature and dew point.
Estimate the relative humidity of the air from the difference between dew point and temperature.

Change of state of water

Condensation, evaporation, sublimation, freezing and melting, latent heat

Define ‘condensation’, ‘evaporation’, ‘sublimation’, ‘freezing and melting’ and ‘latent heat’.
List the conditions for condensation/evaporation.
Explain the condensation process.
Explain the nature of and the need for condensation nuclei.
Explain the effects of condensation on the weather.
List the conditions for freezing/melting.
Explain the process of freezing.
Explain the nature of and the need for freezing nuclei.
Define ‘supercooled water’.
(Refer to Subject 050 09 01 01)
List the conditions for sublimation.
Explain the sublimation process.
Explain the nature of and the need for sublimation nuclei.
Describe the absorption or release of latent heat in each change of state of water.
Illustrate all the changes of state of water with practical examples.

Adiabatic processes

Adiabatic processes, stability of the atmosphere

Describe the adiabatic process in an unsaturated rising or descending air particle.
Explain the variation of temperature of an unsaturated rising or descending air particle.
Explain the variation of humidity of an unsaturated rising or descending air particle.
Describe the adiabatic process in a saturated rising or descending air particle.
Explain the variation of temperature of a saturated air particle with changing altitude.
Explain the static stability of the atmosphere using the actual temperature curve with reference to the adiabatic lapse rates.
Define qualitatively and quantitatively the terms ‘stable’, ‘conditionally unstable’, ‘unstable’ and ‘indifferent’.
Illustrate with a schematic sketch the formation of Foehn.
Explain the effect of the advection of air (warm or cold) on the stability of the air. Remark: Dry adiabatic lapse rate = 1 deg C/100 m or 3 deg C/1 000 ft; average value at lower levels for saturated adiabatic lapse rate = 0.6 deg C/100 m or 1.8 deg C/1 000 ft (values to be used in examinations).

CLOUDS AND FOG

Cloud formation and description

Cloud formation

Explain cloud formation by adiabatic cooling, conduction, advection and radiation.
Describe cloud formation based on the following lifting processes: unorganised lifting in thin layers and turbulent mixing; forced lifting at fronts or over mountains; free convection.
List cloud types typical for stable and unstable air conditions.
Summarise the conditions for the dissipation of clouds.

Cloud types and cloud classification

Describe the different cloud types and their classification.
Identify by shape cirriform, cumuliform and stratiform clouds.
Identify by shape and typical level the 10 cloud types (general).
Describe and identify by shape the following species and supplementary features: castellanus, lenticularis, congestus, calvus, capillatus and virga.
Distinguish between low-, medium- and high-level clouds according to the World Meteorological Organization’s (WMO) ‘cloud etage’.
Distinguish between ice clouds, mixed clouds and pure-water clouds.

Influence of inversions on cloud development

Explain the influence of inversions on vertical movements in the atmosphere.
Explain the influence of an inversion on the formation of stratus clouds.
Explain the influence of ground inversion on the formation of fog.
Describe the role of the tropopause inversion with regard to the vertical development of clouds.

Flying conditions in each cloud type

Assess the 10 cloud types for icing and turbulence.

Fog, mist, haze

General aspects

Define 'fog', 'mist' and 'haze' with reference to the WMO standards of visibility range.
Explain briefly the formation of fog, mist and haze.
Name the factors that generally contribute to the formation of fog and mist.
Name the factors that contribute to the formation of haze.
Describe freezing fog and ice fog.

Radiation fog

Explain the formation of radiation fog.
Describe the significant characteristics of radiation fog, and its vertical extent.
Summarise the conditions for the dissipation of radiation fog.

Advection fog

Explain the formation of advection fog.
Describe the different possibilities of advection-fog formation (over land, sea and coastal regions).
Describe the significant characteristics of advection fog.
Summarise the conditions for the dissipation of advection fog.

Sea smoke

Explain the formation of sea smoke.
Explain the conditions for the development of sea smoke.
Summarise the conditions for the dissipation of sea smoke.

Frontal fog

Explain the formation of frontal fog.
Describe the significant characteristics of frontal fog.
Summarise the conditions for the dissipation of frontal fog.

Orographic fog (hill fog)

Summarise the features of orographic fog.
Describe the significant characteristics of orographic fog.
Summarise the conditions for the dissipation of orographic fog.

PRECIPITATION

Development of precipitation

Process of development of precipitation

Describe the two basic processes of forming precipitation (The Wegener-Bergeron-Findeisen process, Coalescence).
Summarise the outlines of the ice-crystal process (The Wegener-Bergeron-Findeisen process).
Summarise the outlines of the coalescence process.

Explain the development of snow, rain, drizzle and hail.

Types of precipitation

Types of precipitation, relationship with cloud types

List and describe the types of precipitation given in the aerodrome forecast (TAF) and METAR codes (drizzle, rain, snow, snow grains, ice pellets, hail, small hail, snow pellets, ice crystals, freezing drizzle, freezing rain).
State the ICAO/WMO approximate diameters for cloud, drizzle and rain drops.
State that, because of their size, hail stones can cause significant damage to aircraft.
Explain the mechanism for the formation of freezing precipitation.
Describe the weather conditions that give rise to freezing precipitation.
Distinguish between the types of precipitation generated in convective and stratiform clouds.
Assign typical precipitation types and intensities to different cloud types.
Explain the relationship between moisture content and visibility during different types of winter precipitation (e.g. large vs small snowflakes).

AIR MASSES AND FRONTS

Air masses

Description, classification and source regions of air masses

Define the term 'air mass'.
Describe the properties of the source regions.
Summarise the classification of air masses by source regions.
State the classifications of air masses by temperature and humidity at source.
State the characteristic weather in each of the air masses.
Name the three main air masses that affect Europe.

Classify air masses on a surface weather chart. Remark: Names and abbreviations of air masses used in examinations: first letter: humidity: continental (c), maritime (m), second letter: type of air mass: arctic (A), polar (P), tropical (T), equatorial(E), third letter: temperature: cold (c), warm (w).

Modifications of air masses

List the environmental factors that affect the final properties of an air mass.
Explain how maritime and continental tracks modify air masses.
Explain the effect of passage over cold or warm surfaces.
Explain how air-mass weather is affected by the season, the air-mass track and by orographic and thermal effects over land.
Assess the tendencies of the stability of an air mass and describe the typical resulting air-mass weather including the hazards for aviation.

Fronts

General aspects

Describe the boundaries between air masses (fronts).
Define 'front' and 'frontal zone'.
Name the global frontal systems (polar front, arctic front).
State the approximate seasonal latitudes and geographic positions of the polar front and the arctic front.

Warm front, associated clouds and weather

Define a 'warm front'.
Describe the cloud, weather, ground visibility and aviation hazards at a warm front depending on the stability of the warm air.
Explain the seasonal differences in the weather at warm fronts.
Describe the structure, slope and dimensions of a warm front.
Sketch a cross section of a warm front showing weather, cloud and aviation hazards.

Cold front, associated clouds and weather

Define a 'cold front'.
Describe the cloud, weather, ground visibility and aviation hazards at a cold front depending on the stability of the warm air.
Explain the seasonal differences in the weather at cold fronts.
Describe the structure, slope and dimensions of a cold front.
Sketch a cross section of a cold front showing weather, cloud and aviation hazards.

Warm sector, associated clouds and weather

Describe fronts and air masses associated with the warm sector.
Describe the cloud, weather, ground visibility and aviation hazards in a warm sector.
Explain the seasonal differences in the weather in the warm sector.
Sketch a cross section of a warm sector showing weather, cloud and aviation hazards.

Weather behind the cold front

Describe the cloud, weather, ground visibility and aviation hazards behind the cold front.
Explain the seasonal differences in the weather behind the cold front.

Occlusions, associated clouds and weather

Define the term 'occlusion' and 'occluded front'.
Describe the cloud, weather, ground visibility and aviation hazards in a cold occlusion.
Describe the cloud, weather, ground visibility and aviation hazards in a warm occlusion.
Explain the seasonal differences in the weather at occlusions.
Sketch a cross section of occlusions showing weather, cloud and aviation hazards.
On a sketch illustrate the development of an occlusion and the movement of the occlusion point.

Stationary front, associated clouds and weather

Define a 'stationary front'.
Describe the cloud, weather, ground visibility and aviation hazards in a stationary front.

Movement of fronts and pressure systems, life cycle

Describe the movements of fronts and pressure systems and the life cycle of a mid-latitude depression.
State the rules for predicting the direction and the speed of movement of fronts.
State the difference in the speed of movement between cold and warm fronts.
State the rules for predicting the direction and the speed of movement of frontal depressions.
Describe, with a sketch if required, the genesis, development and life cycle of a frontal depression with associated cloud and rain belts.

Changes of meteorological elements at a frontal wave

Sketch a plan and a cross section of a frontal wave (warm front, warm sector, and cold front) and illustrate the changes of pressure, temperature, surface wind and wind in the vertical axis.

PRESSURE SYSTEMS

The principal pressure areas

Location of the principal pressure areas

Identify or indicate on a map the principal global high-pressure and low-pressure areas in January and July.

Explain how these pressure areas are formed.

Explain how the pressure areas move with the seasons.

Anticyclone

Anticyclones, types, general properties, cold and warm anticyclones, ridges and subsidence

List the different types of anticyclones.

Describe the effect of high-level convergence in producing areas of high pressure at ground level.

Describe air-mass subsidence, its effect on the environmental lapse rate, and the associated weather.

Describe the formation of warm and cold anticyclones.

Describe the formation of ridges.

Describe the properties of and the weather associated with warm and cold anticyclones.

Describe the properties of and the weather associated with ridges.

Describe the blocking anticyclone and its effects.

Non-frontal depressions

Thermal, orographic, polar and secondary depressions; troughs

Describe the effect of high-level divergence in producing areas of low pressure at ground level.

Describe the formation and properties of thermal, orographic (lee lows), polar and secondary depressions.

Describe the formation, the properties and the associated weather at troughs.

Tropical revolving storms

Characteristics of tropical revolving storms

State the conditions necessary for the formation of tropical revolving storms.

State how a tropical revolving storm generally moves in its area of occurrence.

Name the stages of the development of tropical revolving storms (tropical disturbance, tropical depression, tropical storm, severe tropical storm, tropical revolving storm).

Describe the meteorological conditions in and near a tropical revolving storm.

State the approximate dimensions of a tropical revolving storm.

State that the movement of a tropical revolving storm can only rarely be forecast exactly, and that utmost care is necessary near a tropical revolving storm.

Origin and local names, location and period of occurrence

List the areas of origin and occurrence of tropical revolving storms, and their specified names (hurricane, typhoon, tropical cyclone).

State the expected times of occurrence of tropical revolving storms in each of the source areas, and their approximate frequency.

CLIMATOLOGY

Climatic zones

General circulation in the troposphere and lower stratosphere

Describe the general tropospheric and low stratospheric circulation.

(Refer to Subject 050 02 03 01)

Climatic classification

Describe the characteristics of the tropical rain climate, the dry climate, the mid-latitude climate (warm temperate rain climate), the subarctic climate (cold snow forest climate) and the snow climate (polar climate).

Explain how the seasonal movement of the sun generates the transitional climate zones.

State the typical locations of each major climatic zone.

Tropical climatology

Cause and development of tropical showers and thunderstorms: humidity, temperature, tropopause

State the conditions necessary for the formation of tropical showers and thunderstorms (mesoscale convective complex, cloud clusters).

Describe the characteristics of tropical squall lines.

Explain the formation of convective cloud structures caused by convergence at the boundary of the NE and SE trade winds (Intertropical Convergence Zone (ITCZ)).

State the typical figures for tropical surface air temperatures and humidities, and for heights of the zero-degree isotherm.

Seasonal variations of weather and wind, typical synoptic situations

Indicate on a map the trade winds (tropical easterlies) and describe the associated weather.

Indicate on a map the doldrums and describe the associated weather.

Indicate on a sketch the latitudes of subtropical high (horse latitudes) and describe the associated weather.

Indicate on a map the major monsoon winds.

Intertropical Convergence Zone (ITCZ), weather in the ITCZ, general seasonal movement

Identify or indicate on a map the positions of the ITCZ in January and July.
Explain the seasonal movement of the ITCZ.
Describe the weather and winds at the ITCZ.
Explain the flight hazards associated with the ITCZ.

Monsoon, sandstorms, cold-air outbreaks

Define in general the term 'monsoon' and give a general overview of regions of occurrence.
Describe the major monsoon conditions.
Explain how trade winds change character after a long track and become monsoon winds.
Explain the weather and the flight hazards associated with a monsoon.
Explain the formation of the SW/NE monsoon over West Africa and describe the weather, stressing the seasonal differences.
Explain the formation of the SW/NE monsoon over India and describe the weather, stressing the seasonal differences.
Explain the formation of the monsoon over the Far East and northern Australia and describe the weather, stressing the seasonal differences.
Describe the formation and properties of sandstorms.
Indicate when and where outbreaks of cold polar air can enter subtropical weather systems.
Name well-known examples of polar-air outbreaks (Blizzard, Pampero).

Easterly waves

Explain the effect of easterly waves on tropical weather systems.

Typical weather situations in the mid-latitudes

Westerly situation (westerlies)

Identify on a weather chart the typical westerly situation with travelling polar front waves.

High-pressure area

Describe the high-pressure zones with the associated weather.
Identify on a weather chart the high-pressure regions.

Cold-air drop

Define 'cold-air drop'.
Describe the formation of a cold-air drop.
Identify cold-air drops on weather charts.
Explain the problems and dangers of cold-air drops for aviation.

Local winds and associated weather

Foehn, Mistral, Bora

Describe the mechanism for the development of Foehn winds (including Chinook).
Describe the weather associated with Foehn winds.
Describe the formation of, the characteristics of, and the weather associated with Mistral and Bora.

Harmattan

Describe the Harmattan wind and the associated visibility problems as an example of local winds affecting visibility.

FLIGHT HAZARDS

Icing

Conditions for ice accretion

Summarise the general conditions under which ice accretion occurs on aircraft (temperatures of outside air; temperature of the airframe; presence of supercooled water in clouds, fog, rain and drizzle; possibility of sublimation).
Explain the general weather conditions under which ice accretion occurs in a venturi carburettor.
Explain the general weather conditions under which ice accretion occurs on airframe.
Explain the formation of supercooled water in clouds, rain and drizzle.
Explain qualitatively the relationship between the air temperature and the amount of supercooled water.
Explain qualitatively the relationship between the type of cloud and the size and number of the droplets in cumuliform and stratiform clouds.
Indicate in which circumstances ice can form on an aircraft on the ground: air temperature, humidity, precipitation.
Explain in which circumstances ice can form on an aircraft in flight: inside clouds, in precipitation, and outside clouds and precipitation.
Explain the influence of fuel temperature, radiative cooling of the aircraft surface and temperature of the aircraft surface (e.g. from previous flight) on ice formation.
Describe the different factors that influence the intensity of icing: air temperature, amount of supercooled water in a cloud or in precipitation, amount of ice crystals in the air, speed of the aircraft, shape (thickness) of the airframe parts (wings, antennas, etc.).
Explain the effects of topography on icing.
Explain the higher concentration of water drops in stratiform orographic clouds.

Types of ice accretion
Define 'clear ice'.
Describe the conditions for the formation of clear ice.
Explain the formation of the structure of clear ice with the release of latent heat during the freezing process.
Describe the aspects of clear ice: appearance, weight, solidity.
Define 'rime ice'.
Describe the conditions for the formation of rime ice.
Describe the aspects of rime ice: appearance, weight, solidity.
Define 'mixed ice'.
Describe the conditions for the formation of mixed ice.
Describe the aspects of mixed ice: appearance, weight, solidity.
Describe the possible process of ice formation in snow conditions.
Define 'hoar frost'.
Describe the conditions for the formation of hoar frost.
Describe the aspects of hoar frost: appearance, solidity.
Hazards of ice accretion, avoidance
State the ICAO qualifying terms for the intensity of icing.
Source: ICAO Doc 4444 'Procedures for Air Navigation Services — Air Traffic Management'
Describe, in general, the hazards of icing.
Assess the dangers of the different types of ice accretion.
Describe the position of the dangerous zones of icing in fronts, in stratiform and cumuliform clouds, and in the different precipitation types.
Indicate the possibilities of avoiding dangerous zones of icing: in the flight planning: weather briefing, selection of track and altitude; during flight: recognition of the dangerous zones, selection of track and altitude.
Ice crystal icing
Describe ice crystal icing.
Describe the atmospheric processes leading to high ice crystal concentration. Define the variable ice water content (IWC).
Identify weather situations and their relevant areas where high concentrations of ice crystals are likely to occur.
Name, in general, the flight hazards associated with high concentrations of ice crystals.
Explain how a pilot may possibly avoid areas with a high concentration of ice crystals.
Turbulence
Effects on flight, avoidance
State the ICAO qualifying terms for the intensity of turbulence.
Source: ICAO Doc 4444 'Procedures for Air Navigation Services — Air Traffic Management'
Describe the effects of turbulence on an aircraft in flight.
Indicate the possibilities of avoiding turbulence: in the flight planning: weather briefing, selection of track and altitude; during flight: selection of appropriate track and altitude.
Describe atmospheric turbulence and distinguish between turbulence, gustiness and wind shear.
Describe that forecasts of turbulence are not very reliable and state that pilot reports of turbulence are very valuable as they help others to prepare for or avoid turbulence.
Clear-air turbulence (CAT): effects on flight, avoidance
Describe the effects of CAT on flight.
(Refer to Subject 050 02 06 03)
Indicate the possibilities of avoiding CAT in flight: in the flight planning: weather briefing, selection of track and altitude; during flight: selection of appropriate track and altitude.
Wind shear
Definition of wind shear
Define 'wind shear' (vertical and horizontal).
Define 'low-level wind shear'.
Weather conditions for wind shear
Describe the conditions, where and how wind shear can form (e.g. thunderstorms, squall lines, fronts, inversions, land and sea breeze, friction layer, relief).
Effects on flight, avoidance
Describe the effects of wind shear on flight.
Indicate the possibilities of avoiding wind shear in flight: in the flight planning; during flight.
Thunderstorms
Conditions for and process of development, forecast, location, type specification
Name the cloud types which indicate the development of thunderstorms.

Describe the different types of thunderstorms, their location, the conditions for and the process of development, and list their properties (air-mass thunderstorms, frontal thunderstorms, squall lines, supercell storms, orographic thunderstorms).

Structure of thunderstorms, life cycle

Assess the average duration of thunderstorms and their different stages.

Describe a supercell storm: initial, supercell, tornado and dissipating stage.

Summarise the flight hazards associated with a fully developed thunderstorm.

Indicate on a sketch the most dangerous zones in and around a single-cell and a multi-cell thunderstorm.

Electrical discharges

Describe the basic outline of the electric field in the atmosphere.

Describe types of lightning, i.e. ground stroke, intra-cloud lightning, cloud-to-cloud lightning, upward lightning.

Describe and assess the 'St. Elmo's fire' weather phenomenon.

Describe the development of lightning discharges.

Describe the effect of lightning strike on aircraft and flight execution.

Development and effects of downbursts

Define the term 'downburst'.

Distinguish between macroburst and microburst.

State the weather situations leading to the formation of downbursts.

Describe the process of development of a downburst.

Give the typical duration of a downburst.

Describe the effects of downbursts.

Thunderstorm avoidance

Explain how the pilot can anticipate each type of thunderstorm: through pre-flight weather briefing, observation in flight, use of specific meteorological information, use of information given by ground weather radar and by airbone weather radar.

(Refer to Subject 050 10 01 04), use of the stormscope (lightning detector).

Describe practical examples of flight techniques used to avoid the hazards of thunderstorms.

Tornadoes

Properties and occurrence

Define 'tornado'.

Describe the formation of a tornado.

Describe the typical features of a tornado such as appearance, season, time of day, stage of development, speed of movement, and wind speed.

Compare the occurrence of tornadoes in Europe with the occurrence in other locations, especially in the United States of America.

Compare the dimensions and properties of tornadoes and dust devils.

Inversions

Influence on aircraft performance

Compare the flight hazards during take-off and approach associated with a strong inversion alone and with a strong inversion combined with marked wind shear.

Stratospheric conditions

Influence on aircraft performance

Summarise the advantages of stratospheric flights.

List the influences of the phenomena associated with the lower stratosphere (wind, temperature, air density, turbulence).

Hazards in mountainous areas

Influence of terrain on clouds and precipitation, frontal passage

Describe the influence of mountainous area on a frontal passage.

Vertical movements, mountain waves, wind shear, turbulence, ice accretion

Describe the vertical movements, wind shear and turbulence that are typical of mountain areas.

Indicate on a sketch of a chain of mountains the turbulent zones (mountain waves, rotors).

Explain the influence of relief on ice accretion.

Development and effect of valley inversions

Describe the formation of a valley inversion due to katabatic winds.

Describe the valley inversion formed by warm winds aloft.

Describe the effects of a valley inversion for an aircraft in flight.

Visibility-reducing phenomena

Reduction of visibility caused by precipitation and obscurations

Describe the reduction of visibility caused by precipitation: drizzle, rain, snow.

Describe the reduction of visibility caused by obscurations: fog, mist, haze, smoke, volcanic ash.

Describe the reduction of visibility caused by obscurations: sand (SA), dust (DU).
Describe the differences between ground and flight visibility, and slant and vertical visibility when an aircraft is above or within a layer of haze or fog.

Reduction of visibility caused by other phenomena

Describe the reduction of visibility caused by low drifting and blowing snow.
Describe the reduction of visibility caused by low drifting and blowing dust and sand.
Describe the reduction of visibility caused by dust storm (DS) and sandstorm (SS).
Describe the reduction of visibility caused by icing (windshield).
Describe the reduction of visibility caused by the position of the sun relative to the visual direction.
Describe the reduction of visibility caused by the reflection of the sun's rays from the top of the layers of haze, fog and clouds.

METEOROLOGICAL INFORMATION

Observation

Surface observations

Define 'gusts', as given in METARs.
Distinguish wind given in METARs and wind given by the control tower for take-off and landing.
Define 'visibility'.
Describe the meteorological measurement of visibility.
Define 'prevailing visibility'.
Define 'ground visibility'.
List the units used for visibility (m, km, statute mile).
Define 'runway visual range'.
Describe the meteorological measurement of runway visual range.
Indicate where the transmissometers/forward-scatter meters are placed on the aerodrome.
List the units used for runway visual range (m, ft).
List the different possibilities to transmit information to pilots about runway visual range.
Compare ground visibility, prevailing visibility, and runway visual range.
Indicate the means of observation of present weather.
Indicate the means of observing clouds for the purpose of recording: type, amount, height of base (ceilometers), and top.
State the clouds which are indicated in METAR, TAF and SIGMET.
Define 'oktas'.
Define 'cloud base'.
Define 'ceiling'.
Name the unit and the reference level used for information about cloud base (ft).
Define 'vertical visibility'.
Explain briefly how and when vertical visibility is measured.
Name the units used for vertical visibility (ft, m).
Indicate the means of observation of air temperature (thermometer).
Name the units of relative humidity (per cent) and dew-point temperature (Celsius, Fahrenheit).

Radiosonde observations

Describe the principle of radiosondes.
Describe and interpret the sounding by radiosonde given on a simplified temperature-pressure (T-P) diagram.

Satellite observations

Describe the basic outlines of satellite observations.
Name the main uses of satellite pictures in aviation meteorology.
Describe the different types of satellite imagery.
Interpret qualitatively the satellite pictures in order to get useful information for flights: location of clouds (distinguish between stratiform and cumuliform clouds).
Interpret qualitatively the satellite pictures in order to get useful information for flights: location of fronts.
Interpret qualitatively the satellite pictures in order to get useful information for flights using atmospheric motion vector images to locate jet streams.

Weather radar observations. (Refer to Subject 050 09 04 05)

Describe the basic principle and the type of information given by a ground weather radar.
Interpret ground weather radar images.
Describe the basic principle and the type of information given by airborne weather radar.
Describe the limits and the errors of airborne weather radar information.
Interpret typical airborne weather radar images.

Aircraft observations and reporting

Describe routine air-report and special air-report (ARS).

State the obligation of a pilot to prepare air-reports.
Name the weather phenomena to be stated in an ARS.

Weather charts

Significant weather charts

Decode and interpret significant weather charts (low, medium and high level).
Describe from a significant weather chart the flight conditions at designated locations or along a defined flight route at a given FL.

Surface charts

Recognise the following weather systems on a surface weather chart (analysed and forecast): ridges, cols and troughs; fronts; frontal side, warm sector and rear side of mid-latitude frontal lows; high- and low-pressure areas.
Determine from surface weather charts the wind direction and speed.

Upper-air charts

Define 'constant-pressure chart'.
Define 'isohypse (contour line)'.
Define 'isotherm'.
Define 'isotach'.
Describe forecast upper-wind and temperature charts.
For designated locations or routes determine from forecast upper-wind and temperature charts, if necessary by interpolation, the spot/average values for outside-air temperature, temperature deviation from ISA, wind direction, and wind speed.

Gridded forecast products

State that numerical weather prediction uses a 3D grid of weather data, consisting of horizontal data (latitude-longitude) and vertical data (height or pressure).
Explain that world area forecast centres prepare global sets of gridded forecasts for flight planning purposes (upper wind, temperature, humidity).
State that the WAFCs also produce gridded datasets for Flight Level and temperature of the tropopause, direction and speed of maximum wind, cumulonimbus clouds, icing and turbulence.
Explain that the data on CB and turbulence can be used in the visualization of flight hazards.
Explain that the gridded forecasts can be merged in information processing systems with data relayed from aircraft or pilot reports, e.g. of turbulence, to provide improved situation awareness.

Information for flight planning

Aviation weather messages

Describe, decode and interpret the following aviation weather messages (given in written or graphical format): METAR, aerodrome special meteorological report (SPECI), trend forecast (TREND), TAF, information concerning en-route weather phenomena which may affect the safety of aircraft operations (SIGMET), information concerning en-route weather phenomena which may affect the safety of low-level aircraft operations (AIRMET), area forecast for low-level flights (GAMET), ARS, volcanic ash advisory information.
Describe, decode and interpret the tropical cyclone advisory information in written and graphical form.
Describe the general meaning of MET REPORT and SPECIAL REPORT.
List, in general, the cases when a SIGMET and an AIRMET are issued.
Describe, decode (by using a code table) and interpret the following messages: runway state message (as written in a METAR).
Remark: For runway state message, refer to ICAO Doc 7754 'Air Navigation Plan — European Region'.

Meteorological broadcasts for aviation

Describe the meteorological content of broadcasts for aviation: meteorological information for aircraft in flight (VOLMET); automatic terminal information service (ATIS).
Describe the meteorological content of broadcasts for aviation: HF-VOLMET.

Use of meteorological documents

Describe meteorological briefing and advice.
List the information that a flight crew can receive from meteorological services for pre-flight planning and apply the content of this information on a designated flight route.
List the meteorological information that a flight crew can receive from flight information services during flight and apply the content of this information for the continuation of the flight.

Meteorological warnings

Describe and interpret aerodrome warnings and wind-shear warnings and alerts.

Meteorological services

World area forecast system and meteorological offices

Name the world area forecast centres (WAFCs) as the provider for upper-air forecasts: WAFCs prepare upper-air gridded forecasts of upper winds; upper-air temperature and humidity; direction, speed and flight level of

maximum wind; flight level and temperature of tropopause, areas of cumulonimbus clouds, icing, clear-air and in-cloud turbulence, and geopotential altitude of flight levels.
Name the meteorological (MET) offices as the provider for aerodrome forecasts and briefing documents.
Name the meteorological watch offices (MWOs) as the provider for SIGMET and AIRMET information.
Name the aeronautical meteorological stations as the provider for METAR and MET reports.
Name the volcanic ash advisory centres (VAACs) as the provider for forecasts of volcanic ash clouds.
Name the tropical cyclone advisory centres (TCACs) as the provider for forecasts of tropical cyclones.

International organisations

Describe briefly the following organisations and their chief activities in relation to weather for aviation: International Civil Aviation Organization (ICAO) (Refer to Subject 010 'AIR LAW'); World Meteorological Organization (WMO).

061. GENERAL NAVIGATION

BASICS OF NAVIGATION

The Earth

Form

State that the geoid is an irregular shape based on the surface of the oceans influenced only by gravity and centrifugal force.
State that a number of different ellipsoids are used to describe the shape of the Earth for mapping but that WGS-84 is the reference ellipsoid required for geographical coordinates.
State that the circumference of the Earth is approximately 40 000 km or approximately 21 600 NM.

Earth rotation

Describe the rotation of the Earth around its own spin axis and the plane of the ecliptic (including the relationship of the spin axis to the plane of the ecliptic).
Explain the effect that the inclination of the Earth's spin axis has on insolation and duration of daylight.

Earth rotation

Position

Position reference system

State that geodetic latitude and longitude is used to define a position on the WGS-84 ellipsoid.
Define geographic (geodetic) latitude and parallels of latitude.
Calculate the difference in latitude between any two given positions.
Define geographic (geodetic) longitude and meridians.
Calculate the difference in longitude between any two given positions.

Direction

Datums

Define 'true north' (TN).
Measure a true direction on any given aeronautical chart.
Define 'magnetic north' (MN).
Define and apply variation.
Explain changes of variation with time and position.
Define 'compass north' (CN).
Apply deviation.

Track and heading

Calculate XWC by: trigonometry; and MDR.
Explain and apply the concepts of drift and WCA.
Calculate the actual track with appropriate data of heading and drift.
Calculate TKE with appropriate data of WCA and drift.
Calculate the heading change at an off-course fix to directly reach the next waypoint using the 1:60 rule.
Calculate the average drift angle based upon an off-course fix observation.

Distance

WGS-84 ellipsoid

State that 1 NM is equal to 1.852 km, which is the average distance of 1' of latitude change on the WGS-84 ellipsoid.
State that 1' of longitude change at the equator on the WGS-84 ellipsoid is approximately equal to 1 NM.

Units

Convert between units of distance (nautical mile (NM), kilometre (km), statute mile (SM), feet (ft), inches (in)).

Graticule distances

Calculate the distance between positions on the same meridian, on opposite (antipodal) meridians, on the same parallel of latitude, and calculate new latitude/longitude when given distances north-south and east-west.

Air mile

Evaluate the effect of wind and altitude on air distance.

Convert between ground distance (NM) and air distance (NAM) using the formula: NAM = NM × TAS/GS.

Speed

True airspeed (TAS)

Calculate TAS from CAS, and CAS from TAS by: mechanical computer; and rule of thumb (2 per cent per 1 000 ft).

Mach number (M)

Calculate TAS from M, and M from TAS.

CAS/TAS/M relationship

Deduce the CAS, TAS and M relationship in climb/descent/cruise (flying at constant CAS or M).

Deduce CAS and TAS in climb/descent/cruise (flying at constant CAS).

Ground speed (GS)

Calculate headwind component (HWC) and tailwind component (TWC) by: trigonometry; and MDR.

Apply HWC and TWC to determine GS from TAS and vice versa.

Explain the relationship between GS and TAS with increasing WCA.

Calculate GS with: mechanical computer (TOV solution); and MDR (given track, TAS and WV).

Perform GS, distance and time calculations.

Calculate revised GS to reach a waypoint at a specific time.

Calculate the average GS based on two observed fixes.

Flight log

Enter revised navigational en-route data, for the legs concerned, into the flight plan (e.g. updated wind and GS and correspondingly losses or gains in time and fuel consumption).

Gradient versus rate of climb/descent

Estimate average climb/descent gradient (per cent) or glide path degrees according to the following rule of thumb:

Gradient in degrees = (vertical distance (ft) / 100) / ground distance (NM))

Gradient in % = (vertical distance (ft) / 60) / ground distance (NM))

Gradient in degrees = arctan (altitude difference (ft) / ground distance (ft)).

N.B. These rules of thumb approximate 1 NM to 6 000 ft and are based on the 1:60 rule.

Calculate rate of descent (ROD) on a given glide-path angle or gradient using the following rule of thumb formulae:

ROD (ft/min) = GP° × GS (NM/min) × 100

ROD (ft/min) = GP % × GS (kt)

Calculate climb/descent gradient (ft/NM, % and degrees), GS or vertical speed according to the following formula:

Vertical speed (ft/min) = (GS (kt) × gradient (ft/NM)) / 60.

State that it is necessary to determine the position of the aircraft accurately before commencing descent in order to ensure safe ground clearance.

Triangle of velocities (TOV)

Construction

Draw and correctly label the TOV.

Solutions

Resolve the TOV for: heading and GS (with mechanical computer and MDR); WV (with mechanical computer); and track and GS (with mechanical computer and MDR).

Dead reckoning (DR)

Dead reckoning (DR) technique

Determine a DR position.

Evaluate the difference between a DR and a fix position.

Define 'speed factor' (SF). Speed divided by 60, used for mental flight-path calculations.

Calculate wind correction angle (WCA) using the formula: WCA = XWC (crosswind component)/SF.

Navigation in climb and descent

Average airspeed

Average TAS used for climb problems is calculated at the altitude 2/3 of the cruising altitude.

Average TAS used for descent problems is calculated at the altitude 1/2 of the descent altitude.

Average wind velocity (WV)

WV used for climb problems is the WV at the altitude 2/3 of the cruising altitude.

WV used for descent problems is the WV at the altitude 1/2 of the descent altitude.

Calculate the average climb/descent GS from given TAS at various altitudes, and WV at various altitudes and true track.

Ground speed (GS)/distance covered during climb or descent

State that most aircraft operating handbooks supply graphical material to calculate climb and descent problems.

Calculate the flying time and distance during climb/descent from given average rate of climb/descent and using average GS using the following formulae valid for a 3°-glide path:

rate of descent = (GS × 10) / 2
rate of descent = speed factor (SF) × glide-path angle × 100
Given distance, speed and present altitude, calculate the rate of climb/descent in order to reach a certain position at a given altitude.
Given speed, rate of climb/descent and altitude, calculate the distance required in order to reach a certain position at a given altitude.
Given speed, distance to go and altitude to climb/descent, calculate the rate of climb/descent.

VISUAL FLIGHT RULE (VFR) NAVIGATION

Ground features

Ground features

Recognise which elements would make a ground feature suitable for use for VFR navigation.

Visual identification

Describe the problems of VFR navigation at lower levels and the causes of reduced visibility.
Describe the problems of VFR navigation at night.

VFR navigation techniques

Use of visual observations and application to in-flight navigation

Describe what is meant by the term 'map reading'.
Define the term 'visual checkpoint'.
Discuss the general features of a visual checkpoint and give examples.
State that the evaluation of the differences between DR positions and actual position can refine flight performance and navigation.
Establish fixes on navigational charts by plotting visually derived intersecting lines of position.
Describe the use of a single observed position line to check flight progress.
Describe how to prepare and align a map/chart for use in visual navigation.
Describe visual-navigation techniques including:
- use of DR position to locate identifiable landmarks;
- identification of charted features/landmarks;
- factors affecting the selection of landmarks;
- an understanding of seasonal and meteorological effects on the appearance and visibility of landmarks;
- selection of suitable landmarks;
- estimation of distance from landmarks from successive bearings;
- estimation of the distance from a landmark using an approximation of the sighting angle and the flight altitude.

Describe the action to be taken if there is no visual checkpoint available at a scheduled turning point.
Understand the difficulties and limitations that may be encountered in map reading in some geographical areas due to the nature of terrain, lack of distinctive landmarks, or lack of detailed and accurate charted data.
State the function of contour lines on a topographical chart.
Indicate the role of 'layer tinting' (colour gradient) in relation to the depiction of topography on a chart.
Using the contours shown on a chart, describe the appearance of a significant feature.
Apply the techniques of DR, map reading, orientation, timing and revision of ETAs and headings.

Unplanned events

Explain what needs to be considered in case of diversion, when unsure of position and when lost.

GREAT CIRCLES AND RHUMB LINES

Great circles

Properties

Describe the geometric properties of a great circle (including the vertex) and a small circle.
Describe the geometric properties of a great circle and a small circle, up to 30° difference of longitude.
Explain why a great-circle route is the shortest distance between any two positions on the Earth.
Name examples of great circles on the surface of the Earth.

Convergence

Explain why the track direction of a great-circle route (other than following a meridian or the equator) changes.
State the formula used to approximate the value of Earth convergence as change of longitude × sine mean latitude.
Calculate the approximate value of Earth convergence between any two positions, up to 30 ° difference of longitude.

Rhumb lines

Properties

Describe the geometric properties of a rhumb line.
State that a rhumb-line route is not the shortest distance between any two positions on the Earth (excluding meridians and equator).

Relationship

Distances

Explain that the variation in distance of the great-circle route and rhumb-line route between any two positions increases with increasing latitude or change in longitude.

Conversion angle

Calculate and apply the conversion angle.

CHARTS

Chart requirements

ICAO Annex 4 'Aeronautical Charts'

State the requirement for conformality and for a straight line to approximate a great circle.

Convergence

Explain and calculate the constant of the cone (sine of parallel of origin).

Explain the relationship between Earth and chart convergence with respect to the ICAO requirement for a straight line to approximate a great circle.

Scale

Recognise methods of representing scale on aeronautical charts.

Perform scale calculations based on typical en-route chart scales.

Projections

Methods of projection

Identify azimuthal, cylindrical and conical projections.

Polar stereographic

State the properties of a polar stereographic projection.

Calculate straight line track changes on a polar stereographic chart.

Direct Mercator

State the properties of a direct Mercator projection.

Given the scale at one latitude, calculate the scale at different latitudes.

Given a chart length at one latitude, show that it represents a different Earth distance at other latitudes.

Lambert

State the properties of a Lambert projection.

Calculate straight line track changes on a Lambert chart.

Explain the scale variation throughout the charts as follows:

- the scale indicated on the chart will be correct at the standard parallels;
- the scale will increase away from the parallel of origin;
- the scale within the standard parallels differs by less than 1 % from the scale stated on the chart.

Given appropriate data, calculate initial, final or rhumb-line tracks between two positions (lat./long.).

Given two positions (lat./long.) and information to determine convergency between the two positions, calculate the parallel of origin.

Given a Lambert chart, determine the parallel of origin, or constant of cone.

Given constant of cone or parallel of origin, great-circle track at one position and great-circle track at another position, calculate the difference of longitude between the two positions.

Practical use

Symbology

Recognise ICAO Annex 4 symbology.

Plotting

Measure tracks and distances on VFR and IFR en-route charts.

Fix the aircraft position on an en-route chart with information from VOR and DME equipment.

Resolve bearings of an NDB station for plotting on an aeronautical chart.

Time

Local Mean Time (LMT)

Mean solar day

Explain the concepts of a mean solar day and LMT.

Local Mean Time (LMT) and Universal Time Coordinated (UTC)

Perform LMT and UTC calculations.

Standard time

Standard time and daylight saving time

Explain and apply the concept of standard time and daylight saving time, and perform standard time and daylight saving time calculations.

International Date Line

State the changes when crossing the International Date Line.

Sunrise and sunset

Sunrise and sunset times

Define sunrise, sunset, and civil twilight, and extract times from a suitable source (e.g. an almanac).

Explain the changes to sunrise, sunset, and civil twilight times with date, latitude and altitude.
Explain at which time of the year the duration of daylight changes at the highest rate.

062. RADIO NAVIGATION

BASIC RADIO PROPAGATION THEORY
Basic principles
Electromagnetic waves
State that radio waves travel at the speed of light, being approximately 300 000 km/s.
Define a 'cycle': a complete series of values of a periodical process.
Frequency, wavelength, amplitude, phase angle
Define 'frequency': the number of cycles occurring in 1 second expressed in Hertz (Hz).
Define 'wavelength': the physical distance travelled by a radio wave during one cycle of transmission.
Define 'amplitude': the maximum deflection in an oscillation or wave.
State that the relationship between wavelength and frequency is: wavelength (λ) = speed of light (c) / frequency (f).
Define 'phase angle': the fraction of one wavelength expressed in degrees from 000° to 360°.
Define 'phase angle difference/shift': the angular difference between the corresponding points of two cycles of equal wavelength, which is measurable in degrees (deg).
Frequency bands, sidebands, single sideband
List the bands of the frequency spectrum for electromagnetic waves: very low frequency (VLF): 3-30 kHz; low frequency (LF): 30-300 kHz; medium frequency (MF): 300-3 000 kHz; high frequency (HF): 3-30 MHz; very high frequency (VHF): 30-300 MHz; ultra high frequency (UHF): 300-3 000 MHz; super high frequency (SHF): 3-30 GHz; extremely high frequency (EHF): 30-300 GHz.
State that when a carrier wave is modulated, the resultant radiation consists of the carrier frequency plus additional upper and lower sidebands.
State that HF meteorological information for aircraft in flight (VOLMET) and HF two-way communication use a single sideband.
State that the following abbreviations (classifications according to International Telecommunication Union (ITU) regulations) are used for aviation applications: N0N: carrier without modulation as used by non-directional radio beacons (NDBs); A1A: carrier with keyed Morse code modulation as used by NDBs; A2A: carrier with amplitude modulated Morse code as used by NDBs; A3E: carrier with amplitude modulated speech used for communication (VHF-COM).
Pulse characteristics
Define the following terms that are associated with a pulse string: - pulse length; - pulse power; - continuous power.
Carrier, modulation
Define 'carrier wave': the radio wave acting as the carrier or transporter.
Define 'modulation': the technical term for the process of impressing and transporting information by radio waves.
Kinds of modulation (amplitude, frequency, pulse, phase)
Define 'amplitude modulation': the information that is impressed onto the carrier wave by altering the amplitude of the carrier.
Define 'frequency modulation': the information that is impressed onto the carrier wave by altering the frequency of the carrier.
Describe 'pulse modulation': a modulation form used in radar by transmitting short pulses followed by larger interruptions.
Describe 'phase modulation': a modulation form used in GPS where the phase of the carrier wave is reversed.
Antennas
Characteristics
Define 'antenna': an antenna or aerial is an electrical device which converts electric power into radio waves, and vice versa.
State that the simplest type of antenna is a dipole, which is a wire of length equal to one half of the wavelength.
State that an electromagnetic wave always consists of an oscillating electric (E) and an oscillating magnetic (H) field which propagates at the speed of light.
State that the E and H fields are perpendicular to each other. The oscillations are perpendicular to the propagation direction and are in-phase.
Polarisation
State that the polarisation of an electromagnetic wave describes the orientation of the plane of oscillation of the electrical component of the wave with regard to its direction of propagation.
Types of antennas

Name the common different types of directional antennas: loop antenna used in old automatic direction-finding (ADF) receivers; parabolic antenna used in weather radars; slotted planar array used in more modern weather radars.
Explain 'antenna shadowing'.
Explain the importance of antenna placement on aircraft.

Wave propagation

Structure of the ionosphere and its effect on radio waves

State that the ionosphere is the ionised component of the Earth's upper atmosphere from approximately 60 to 400 km above the surface, which is vertically structured in three regions or layers.
State that the layers of the ionosphere are named D, E and F layers, and their depth varies with time.
State that electromagnetic waves refracted from the E and F layers of the ionosphere are called sky waves.
Explain how the different layers of the ionosphere influence wave propagation.

Ground waves

Define 'ground or surface waves': the electromagnetic waves travelling along the surface of the Earth.

Space waves

Define 'space waves': the electromagnetic waves travelling through the air directly from the transmitter to the receiver.

Propagation with the frequency bands

State that radio waves in VHF, UHF, SHF and EHF propagate as space waves.
State that radio waves in LF, MF and HF propagate as surface/ground waves and sky waves.

Doppler principle

State that the Doppler effect is the phenomenon where the frequency of a wave will increase or decrease if there is relative motion between the transmitter and the receiver.

Factors affecting propagation

Define 'skip distance': the distance between the transmitter and the point on the surface of the Earth where the first sky wave return arrives.
State that skip zone/dead space is the distance between the limit of the surface wave and the sky wave.
Describe 'fading': when a receiver picks up two signals with the same frequency, and the signals will interfere with each other causing changes in the resultant signal strength and polarisation.
State that radio waves in the VHF band and above are limited in range as they are not reflected by the ionosphere and do not have a surface wave.
Describe the physical phenomena 'reflection', 'refraction', 'diffraction', 'absorption' and 'interference'.
State that multipath is when the signal arrives at the receiver via more than one path (the signal being reflected from surfaces near the receiver).

RADIO AIDS

Ground direction finding (DF)

Principles

Describe the use of a ground DF.
Explain the limitation of range because of the path of the VHF signal.

Presentation and interpretation

Define the term 'QDM': the magnetic bearing to the station.
Define the term 'QDR': the magnetic bearing from the station.
Explain that by using more than one ground station, the position of an aircraft can be determined and transmitted to the pilot.

Coverage and range

Use the formula: 1.23 x √transmitter height in feet + 1.23 x √receiver height in feet, to calculate the range in NM.

Errors and accuracy

Explain why synchronous transmissions will cause errors.
Describe the effect of 'multipath signals'.
Explain that VDF information is divided into the following classes according to ICAO Annex 10: - Class A: accurate to a range within ± 2°; - Class B: accurate to a range within ± 5°; - Class C: accurate to a range within ± 10°; - Class D: accurate to less than Class C.

Non-directional radio beacon (NDB)/automatic direction finding (ADF)

Principles

Define the acronym 'NDB': non-directional radio beacon.
Define the acronym 'ADF': automatic direction-finding equipment.
State that the NDB is the ground part of the system.
State that the ADF is the airborne part of the system.
State that the NDB operates in the LF and MF frequency bands.
State that the frequency band assigned to aeronautical NDBs according to ICAO Annex 10 is 190-1 750 kHz.

Define a 'locator beacon': an LF/MF NDB used as an aid to final approach usually with a range of 10-25 NM.
State that certain commercial radio stations transmit within the frequency band of the NDB.
State that according to ICAO Annex 10, an NDB station has an automatic ground monitoring system.
Describe the use of NDBs for navigation.
Describe the procedure to identify an NDB station.
Interpret the term 'cone of confusion' in respect of an NDB.
State that an NDB station emits a N0N/A1A or a N0N/A2A signal.
State the function of the beat frequency oscillator (BFO).
State that in order to identify a N0N/A1A NDB, the BFO circuit of the receiver has to be activated.
State that on modern aircraft, the BFO is activated automatically.

Presentation and interpretation

Name the types of indicators commonly in use: - electronic display; - radio magnetic indicator (RMI); - fixed-card ADF (radio compass); - moving-card ADF.
Interpret the indications given on RMI, fixed-card and moving-card ADF displays.
Given a display, interpret the relevant ADF information.
Calculate the true bearing from the compass heading and relative bearing.
Convert the compass bearing into magnetic bearing and true bearing.
Describe how to fly the following in-flight ADF procedures: homing and tracking, and explain the influence of wind; interceptions of inbound QDM and outbound QDR; changing from one QDM/QDR to another; determining station passage and the abeam point.

Coverage and range

State that the power of the transmitter limits the range of an NDB.
Explain the relationship between power and range.
Describe the propagation path of NDB radio waves with respect to the ionosphere and the Earth's surface.
Explain that the interference between sky waves and ground waves leads to 'fading'.
Define that the accuracy the pilot has to fly the required bearing in order to be considered established during approach, according to ICAO Doc 8168, has to be within ± 5°.
State that there is no warning indication of NDB failure.

Errors and accuracy

Explain 'coastal refraction': as a radio wave travelling over land crosses the coast, the wave speeds up over water and the wave front bends.
Define 'night/twilight effect': the influence of sky waves and ground waves arriving at the ADF receiver with a difference of phase and polarisation which introduce bearing errors.
State that interference from other NDB stations on the same frequency may occur at night due to sky-wave contamination.

Factors affecting range and accuracy

Describe diffraction of radio waves in mountainous terrain (mountain effect).
State that static radiation energy from a cumulonimbus cloud may interfere with the radio wave and influence the ADF bearing indication.
Explain that the bank angle of the aircraft causes a dip error.

VHF omnidirectional radio range (VOR): conventional VOR (CVOR) and Doppler VOR (DVOR)

Principles

Explain the working principle of VOR using the following general terms: - reference phase; - variable phase; - phase difference.
State that the frequency band allocated to VOR according to ICAO Annex 10 is VHF, and the frequencies used are 108.0-117.975 MHz.
State that frequencies within the allocated VOR range 108.0-111.975 MHz, which have an odd number in the first decimal place, are used by instrument landing system (ILS).
State that the following types of VOR are in operation: - conventional VOR (CVOR): a first-generation VOR station emitting signals by means of a rotating antenna; - Doppler VOR (DVOR): a second-generation VOR station emitting signals by means of a combination of fixed antennas utilising the Doppler principle; en-route VOR for use by IFR traffic; - terminal VOR (TVOR): a station with a shorter range used as part of the approach and departure structure at major aerodromes; - test VOR (VOT): a VOR station emitting a signal to test VOR indicators in an aircraft.
State that automatic terminal information service (ATIS) information is transmitted on VOR frequencies.
List the three main components of VOR airborne equipment: the antenna; the receiver; the indicator.
Describe the identification of a VOR in terms of Morse-code letters and additional plain text.
State that according to ICAO Annex 10, a VOR station has an automatic ground monitoring system.
State that failure of the VOR station to stay within the required limits can cause the removal of identification and navigation components from the carrier or radiation to cease.

Presentation and interpretation
Read off the radial on an RMI.
Read off the angular displacement in relation to a preselected radial on a horizontal situation indicator (HSI) or omnibearing indicator (OBI).
Explain the use of the TO/FROM indicator in order to determine aircraft position relative to the VOR considering also the heading of the aircraft.
Interpret VOR information as displayed on HSI, CDI and RMI.
Describe the following in-flight VOR procedures: tracking, and explain the influence of wind when tracking; interceptions of a radial inbound and outbound to/from a VOR; changing from one radial inbound/outbound to another; determining station passage and the abeam point.
State that when converting a radial into a true bearing, the variation at the VOR station has to be taken into account.
Errors and accuracy
Define that the accuracy the pilot has to fly the required bearing in order to be considered established on a VOR track when flying approach procedures, according to ICAO Doc 8168, has to be within the half-full scale deflection of the required track.
State that due to reflections from terrain, radials can be bent and lead to wrong or fluctuating indications, which is called 'scalloping'.
Distance-measuring equipment (DME)
Principles
State that DME operates in the UHF band.
State that the system comprises two basic components: - the aircraft component: the interrogator; - the ground component: the transponder.
Describe the principle of distance measurement using DME in terms of a timed transmission from the interrogator and reply from the transponder on different frequencies.
Explain that the distance measured by DME is slant range.
Illustrate that a position line using DME is a circle with the station at its centre.
State that the pairing of VHF and UHF frequencies (VOR/DME) enables the selection of two items of navigation information from one frequency setting.
Describe, in the case of co-location with VOR and ILS, the frequency pairing and identification procedure.
State that military UHF tactical air navigation aid (TACAN) stations may be used for DME information.
Presentation and interpretation
State that when identifying a DME station co-located with a VOR station, the identification signal with the higher-tone frequency is the DME which identifies itself approximately every 40 seconds.
Calculate ground distance from given slant range and altitude.
Describe the use of DME to fly a DME arc in accordance with ICAO Doc 8168 Volume 1.
State that a DME system may have a ground speed (GS) and time to station read-out combined with the DME read-out.
Coverage and range
Explain why a ground station can generally respond to a maximum of 100 aircraft.
Explain which aircraft will be denied a DME range first when more than 100 interrogations are being made.
Factors affecting range and accuracy
Explain why the GS read-out from a DME can be less than the actual GS, and is zero when flying a DME arc.
Instrument landing system (ILS)
Principles
Name the three main components of an ILS: - the localiser (LOC); - the glide path (GP); range information (markers or DME).
State the site locations of the ILS components: - the LOC antenna should be located on the extension of the runway centre line at the stop-end; - the GP antenna should be located beyond the runway threshold, laterally displaced to the side of the runway centre line.
Explain that marker beacons produce radiation patterns to indicate predetermined distances from the threshold along the ILS GP.
State that marker beacons are sometimes replaced by a DME paired with the LOC frequency.
State that in the ILS LOC frequency assigned band 108.0-111.975 MHz, only frequencies which have an odd number in the first decimal are ILS LOC frequencies.
State that the GP operates in the UHF band.
Describe the use of the 90-Hz and the 150-Hz signals in the LOC and GP transmitters/receivers, stating how the signals at the receivers vary with angular deviation.
State that the UHF GP frequency is selected automatically by being paired with the LOC frequency.

Explain that both the LOC and the GP antenna radiate side lobes (false beams) which can give rise to false centre-line and false GP indication.
Explain that the back beam from the LOC antenna may be used as a published 'non-precision approach'.
State that the recommended GP is 3°.
Name the frequency, modulation and identification assigned to all marker beacons. All marker beacons operate on 75-MHz carrier frequency. The modulation frequencies of the audio are: - outer marker: low; - middle marker: medium; - inner marker: high. The audio frequency modulation (for identification) is the continuous modulation of the audio frequency and is keyed as follows: - outer marker: 2 dashes per second continuously; - middle marker: a continuous series of alternate dots and dashes; inner marker: 6 dots per second continuously. The outer-marker cockpit indicator is coloured blue, the middle marker amber, and the inner marker white.
State that the final-approach area contains a fix or facility that permits verification of the ILS GP-altimeter relationship. The outer marker or DME is usually used for this purpose.

Presentation and interpretation

Describe the ILS identification regarding frequency and Morse code or plain text.
State that an ILS installation has an automatic ground monitoring system.
State that the LOC and GP monitoring system monitors any shift in the LOC and GP mean course line or reduction in signal strength.
State that warning flags will appear for both the LOC and the GP if the received signal strength is below a threshold value.
Describe the circumstances in which warning flags will appear for both the LOC and the GP: absence of the carrier frequency; absence of the modulation simultaneously; the percentage modulation of the navigation signal reduced to 0.
Interpret the indications on a CDI and an HSI: full-scale deflection of the CDI needle corresponds to approximately 2.5° displacement from the ILS centre line; - full-scale deflection on the GP corresponds to approximately 0.7° from the ILS GP centre line.
Interpret the aircraft's position in relation to the extended runway centre line on a back-beam approach.
Explain the setting of the course pointer of an HSI and the course selector of an omnibearing indicator (OBI) for front-beam and back-beam approaches.

Coverage and range

Sketch the standard coverage area of the LOC and GP with angular sector limits in degrees and distance limits from the transmitter: - LOC coverage area is 10° on either side of the centre line to a distance of 25 NM from the runway, and 35° on either side of the centre line to a distance of 17 NM from the runway; - GP coverage area is 8° on either side of the centre line to a distance of minimum 10 NM from the runway.

Errors and accuracy

Explain that ILS approaches are divided into facility performance categories defined in ICAO Annex 10.
Define the following ILS operation categories: - Category I; - Category II; - Category IIIA; - Category IIIB; - Category IIIC.
Explain that all Category III ILS operations guidance information is provided from the coverage limits of the facility to, and along, the surface of the runway.
Explain why the accuracy requirements are progressively higher for CAT I, CAT II and CAT III ILS.
Explain the following in accordance with ICAO Doc 8168: - the accuracy the pilot has to fly the ILS LOC to be considered established on an ILS track is within the half-full scale deflection of the required track; - the aircraft has to be established within the half-scale deflection of the LOC before starting descent on the GP; - the pilot has to fly the ILS GP to a maximum of half-scale fly-up deflection of the GP in order to stay in protected airspace.
State that if a pilot deviates by more than half-course deflection on the LOC or by more than half-dot deflection on the GP, an immediate go-around should be executed because obstacle clearance may no longer be guaranteed.
Describe ILS beam bends as deviations from the nominal LOC and GP respectively which can be assessed by flight test.
Explain that multipath interference is caused by reflections from objects within the ILS coverage area.

Factors affecting range and accuracy

Define the 'ILS-critical area': an area of defined dimensions around the LOC and GP antennas where vehicles, including aircraft, are excluded during all ILS operations.
Define the 'ILS-sensitive area': an area extending beyond the ILS-critical area where the parking or movement of vehicles, including aircraft, is controlled to prevent the possibility of unacceptable interference to the ILS signal during ILS operations.

Microwave landing system (MLS)

Principles

Explain the principle of operation: - horizontal course guidance during the approach; - vertical guidance during the approach; - horizontal guidance for departure and missed approach; - DME (DME/P) distance; - transmission of special information regarding the system and the approach conditions.

State that MLS operates in the SHF band on any one of 200 channels, on assigned frequencies.
Explain the reason why MLS can be installed at aerodromes where, as a result of the effects of surrounding buildings or terrain, ILS siting is difficult.

Presentation and interpretation

Interpret the display of airborne equipment designed to continuously show the position of the aircraft in relation to a preselected course and glide path, along with distance information, during approach and departure.
Explain that segmented approaches can be carried out with a presentation with two cross bars directed by a computer which has been programmed with the approach to be flown.
Illustrate that segmented and curved approaches can only be executed with DME/P installed.
Explain why aircraft are equipped with a multimode receiver (MMR) in order to be able to receive ILS, MLS and GPS.
Explain why MLS without DME/P gives an ILS lookalike straight-line approach.

Coverage and range

Describe the coverage area for the approach direction as being within a sector of +/- 40° of the centre line out to a range of 20 NM from the threshold (according to ICAO Annex 10).

RADAR

Pulse techniques

Pulse techniques and associated terms

Name the different applications of radar with respect to air traffic control (ATC), weather observations, and airborne weather radar (AWR).
Describe the pulse technique and echo principle on which primary radar systems are based.
State that the range of a radar depends on pulse repetition frequency (PRF), pulse length, pulse power, height of aircraft, height of antenna and frequency used.

Ground radar

Principles

Explain that primary radar provides bearing and distance of targets.
Explain that primary ground radar is used to detect aircraft that are not equipped with a secondary radar transponder.

Presentation and interpretation

State that modern ATC systems use inputs from various sensors to generate the display.

Airborne weather radar

Principles

List the two main tasks of the weather radar in respect of weather and navigation.
State that modern weather radars employ frequencies that give wavelengths of about 3 cm that reflect best on wet hailstones.
State that the antenna is stabilised in the horizontal plane with signals from the aircraft's attitude reference system.
Describe the cone-shaped pencil beam of about 3° to 5° beam width used for weather detection.

Presentation and interpretation

Explain the functions of the following different controls on the radar control panel: - off/on switch; - function switch with WX, WX+T and MAP modes; - gain-control setting (auto/manual); -tilt/autotilt switch.
Name, for areas of differing reflection intensity, the colour gradations (green, yellow, red and magenta) indicating the increasing intensity of precipitation.
State the use of azimuth-marker lines and range lines in respect of the relative bearing and the distance to a thunderstorm on the screen.

Coverage and range

Explain how the radar is used for weather detection and for mapping (range, tilt and gain, if available).

Errors, accuracy, limitations

Explain why AWR should be used with extreme caution when on the ground.

Factors affecting range and accuracy

Explain the danger of the area behind heavy rain (shadow area) where no radar waves will penetrate.
Describe appropriate tilt settings in relation to altitude and thunderstorms.
Explain why a thunderstorm may not be detected when the tilt is set too high.

Application for navigation

Describe the navigation function of the radar in the mapping mode.
Describe the use of the weather radar to avoid a thunderstorm (Cb).
Explain how turbulence (not CAT) can be detected by a modern weather radar.
Explain how wind shear can be detected by a modern weather radar.

Secondary surveillance radar and transponder

Principles

State that the ATC system is based on the replies provided by the airborne transponders in response to interrogations from the ATC secondary radar.

State that the ground ATC secondary radar uses techniques which provide the ATC with information that cannot be acquired by the primary radar.

State that an airborne transponder provides coded-reply signals in response to interrogation signals from the ground secondary radar and from aircraft equipped with traffic alert and collision avoidance system (TCAS).

State the advantages of secondary surveillance radar (SSR) over a primary radar regarding range and collected information due to transponder principle, information and active participation of the aircraft.

Modes and codes

State that the interrogator transmits its interrogations in the form of a series of pulse pairs.

Name the interrogation modes: Mode A; Mode C; Mode S.

State that the interrogation frequency and the reply frequency are different.

Explain that the decoding of the time interval between the pulse pairs determines the operating mode of the transponder: - Mode A: transmission of aircraft transponder code; - Mode C: transmission of aircraft pressure altitude; - Mode S: selection of aircraft address and transmission of flight data for the ground surveillance.

State that Mode A designation is a sequence of four digits which can be manually selected from 4096 available codes.

State that in Mode C reply, the pressure altitude is reported in 100-ft increments.

State that in addition to the information provided, on request from ATC, a special position identification (SPI) pulse can be transmitted but only as a result of a manual selection by the pilot (IDENT button).

State the need for compatibility of Mode S with Mode A and C.

Explain that Mode S transponders receive interrogations from TCAS and SSR ground stations.

State that Mode S interrogation contains either the aircraft address, selective call or all-call address.

State that every aircraft is allocated an ICAO aircraft address, which is hard-coded into the Mode S transponder (Mode S address).

Explain that a 24-bit address is used in all Mode S transmissions, so that every interrogation can be directed to a specific aircraft.

State that Mode S can provide enhanced vertical tracking, using a 25-ft altitude increment.

State that SSR can be used for automatic dependent surveillance — broadcast (ADS-B).

Presentation and interpretation

State that an aircraft can be identified by a unique code.

State which information can be presented on the ATC display system: pressure altitude; flight level; flight number or aircraft registration number; GS.

Explain the use and function of the selector modes: OFF, Standby, ON (Mode A), ALT (Mode A, C and S), TEST, and of the reply lamp.

GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSSs)

Global navigation satellite systems (GNSSs)

General

State that there are four main GNSSs. These are: USA NAVigation System with Timing And Ranging Global Positioning System (NAVSTAR GPS); Russian GLObal NAvigation Satellite System (GLONASS); European Galileo (under construction); Chinese BeiDou (under construction).

State that all four systems (will) consist of a constellation of satellites which can be used by a suitably equipped receiver to determine position.

Operation

Global navigation satellite system (GNSS)

State that there are currently two modes of operation: standard positioning service (SPS) for civilian users, and precise positioning service (PPS) for authorised users.

SPS was originally designed to provide civilian users with a less accurate positioning capability than PPS.

Name the three GNSS segments as follows: space segment; control segment; user segment.

Space segment (example: NAVSTAR GPS)

State that each satellite broadcasts ranging signals on two UHF frequencies: L1 and L2.

State that SPS is a positioning and timing service provided on frequency L1.

State that PPS uses both frequencies L1 and L2.

State that the satellites transmit a coded signal used for ranging, identification (satellite individual PRN code), timing and navigation.

State that the navigation message contains: satellite clock correction parameters; Universal Time Coordinated (UTC) parameters; an ionospheric model; satellite health data.

State that an ionospheric model is used to calculate the time delay of the signal travelling through the ionosphere.

State that two codes are transmitted on the L1 frequency, namely a coarse acquisition (C/A) code and a precision (P) code. The P code is not used for standard positioning service (SPS).

State that satellites are equipped with atomic clocks which allow the system to keep very accurate time reference.

Control segment

State that the control segment comprises: a master control station; a ground antenna; monitoring stations.

State that the control segment provides: monitoring of the constellation status; correction of orbital parameters; navigation data uploading.

User segment

State that GNSS supplies three-dimensional position fixes and speed data, plus a precise time reference.

State that a GNSS receiver is able to determine the distance to a satellite by determining the difference between the time of transmission by the satellite and the time of reception.

State that the initial distance calculated to the satellites is called pseudo-range because the difference between the GNSS receiver and the satellite time references initially creates an erroneous range.

State that each range defines a sphere with its centre at the satellite.

State that there are four unknown parameters (x, y, z and delta t) (receiver clock error) which require the measurement of ranges to four different satellites in order to get the position.

State that the GNSS receiver is able to synchronise to the correct time reference when receiving four satellites.

State that the receiver is able to calculate aircraft ground speed using the space vehicle (SV) Doppler frequency shift or the change in receiver position over time.

NAVigation System with Timing And Ranging Global Positioning System (NAVSTAR GPS) integrity

Define 'receiver autonomous integrity monitoring (RAIM)' as a technique that ensures the integrity of the provided data by redundant measurements.

State that RAIM is achieved by consistency checks among range measurements.

State that basic RAIM requires five satellites. A sixth one is for isolating a faulty satellite from the navigation solution.

State that agreements have been concluded between the appropriate agencies for the compatibility and interoperability by any approved user of NAVSTAR and GLONASS systems.

State that the different GNSSs use different data with respect to reference systems, orbital data, and navigation services.

Errors and factors affecting accuracy

List the most significant factors that affect accuracy: ionospheric propagation delay; dilution of precision; satellite clock error; satellite orbital variations; multipath.

State that a user equivalent range error (UERE) can be computed from all these factors.

State that the error from the ionospheric propagation delay (IPD) can be reduced by modelling, using a model of the ionosphere, or can almost be eliminated by using two frequencies.

State that ionospheric delay is the most significant error.

State that dilution of precision arises from the geometry and number of satellites in view. It is called geometric dilution of precision (GDOP).

State that the UERE in combination with the geometric dilution of precision (GDOP) allows for an estimation of position accuracy.

State that errors in the satellite orbits are due to: solar winds; gravitation of the Sun and the Moon.

Ground-, satellite- and aircraft-based augmentation systems

Ground-based augmentation systems (GBASs)

Explain the principle of a GBAS: to measure on the ground the errors in the signals transmitted by GNSS satellites and relay the measured errors to the user for correction.

State that the ICAO GBAS standard is based on this technique through the use of a data link in the VHF band of ILS-VOR systems (108-118 MHz).

State that for a GBAS station the coverage is about 20 NM.

State that GBAS provides information for guidance in the terminal area, and for three-dimensional guidance in the final approach segment (FAS) by transmitting the FAS data block.

State that one ground station can support all the aircraft subsystems within its coverage providing the aircraft with approach data, corrections and integrity information for GNSS satellites in view via a VHF data broadcast (VDB).

State that the minimum software designed coverage area is 10 deg on either side of the final approach path to a distance between 15 and 20 NM, and 35 deg on either side of the final approach path up to a distance of 15 NM.

State that outside this area the FAS data of GBAS is not used.

State that GBAS based on GPS is sometimes called local area augmentation system (LAAS).

State that a GBAS-based approach is called GLS approach (GLS-GNSS landing system).

Satellite-based augmentation systems (SBASs)

Explain the principle of an SBAS: to measure on the ground the errors in the signals received from the satellites and transmit differential corrections and integrity messages for navigation satellites.

State that the frequency band of the data link is identical to that of the GPS signals.
Explain that the use of geostationary satellites enables messages to be broadcast over very wide areas.
State that pseudo-range measurements to these geostationary satellites can also be made, as if they were GPS satellites.
State that SBAS consists of two elements: ground infrastructure (monitoring and processing stations); communication satellites.
State that SBAS allows the implementation of three-dimensional Type A and Type B approaches, and it can provide approach procedure with vertical guidance (APV).
State the following examples of SBAS: European geostationary navigation overlay service (EGNOS) in western Europe and the Mediterranean; wide area augmentation system (WAAS) in the USA; multi-functional transport satellite (MTSAT)-based augmentation system (MSAS) in Japan; GPS and geostationary earth orbit augmented navigation (GAGAN) in India.
State that SBAS is designed to significantly improve accuracy and integrity.
Explain that integrity and safety are improved by alerting SBAS users within 6 seconds if a GPS malfunction occurs.

Aircraft-based augmentation systems (ABASs)

Explain the principle of ABAS: to use redundant elements within the GPS constellation (e.g. multiplicity of distance measurements to various satellites) or the combination of GNSS measurements with those of other navigation sensors (such as inertial systems) in order to develop integrity control.
State that the type of ABAS using only GNSS information is named receiver autonomous integrity monitoring (RAIM).
State that a system using information from additional onboard sensors is named aircraft autonomous integrity monitoring (AAIM).
Explain that the typical sensors used are barometric altimeter and inertial reference system (IRS).

PERFORMANCE-BASED NAVIGATION (PBN)

Performance-based navigation (PBN) concept (as described in ICAO Doc 9613)

PBN principles

List the factors used to define area navigation (RNAV) or required navigation performance (RNP) system performance requirements (accuracy, integrity and continuity).
State that these RNAV and RNP systems are necessary to optimise the utilisation of available airspace.
State that it is necessary for flight crew and air traffic controllers to be aware of the on-board RNAV or RNP system capabilities in order to determine whether the performance of the RNAV or RNP system is appropriate for the specific airspace requirements.
Define accuracy as the conformance of the true position and the required position.
Define continuity as the capability of the system to perform its function without unscheduled interruptions during the intended operation.
Define integrity as a measure of the trust that can be placed in the correctness of the information supplied by the total system. Integrity includes the ability of a system to provide timely and valid alerts to the user.
State that, unlike conventional navigation, PBN is not sensor-specific.
Explain the difference between raw data and computed data.
Define availability as the percentage of time (annually) during which the system is available for use.

PBN components

List the components of PBN as navigational aid (NAVAID) infrastructure, navigation specification and navigation application.

PBN scope

State that in oceanic/remote, en-route and terminal phases of flight, PBN is limited to operations with linear lateral performance requirements and time constraints.
State that in the approach phases of flight, PBN accommodates both linear and angular laterally guided operations, and explain the difference between the two.

Navigation specifications

Area navigation (RNAV) and required navigation performance (RNP)

State the difference between RNAV and RNP in terms of the requirement for on-board performance monitoring and alerting.

Navigation functional requirements

List the basic functional requirements of the RNAV and RNP specifications (continuous indication of lateral deviation, distance/bearing to active waypoint, GS or time to active waypoint, navigation data storage and failure indication).

Designation of RNP and RNAV specifications

Interpret X in RNAV X or RNP X as the lateral navigation (LNAV) accuracy (total system error) in nautical miles, which is expected to be achieved at least 95 % of the flight time by the population of aircraft operating within the given airspace, route or procedure.

State that aircraft approved to the more stringent accuracy requirements may not necessarily meet some of the functional requirements of the navigation specification that has a less stringent accuracy requirement.
State that RNAV 10 and RNP 4 are used in the oceanic/remote phase of flight.
State that RNAV 5 is used in the en-route and arrival phases of flight.
State that RNAV 2 and RNP 2 are also used as navigation specifications.
State that RNP 2 is used in the en-route and oceanic/remote phases of flight.
State that RNAV 2 might be used in the en-route continental, arrival and departure phases of flight.
State that RNAV 1 and RNP 1 are used in the arrival and departure phases of flight.
State that required navigation performance approach (RNP APCH) is used in the approach phase of flight.
State that required navigation performance authorisation required approach (RNP AR APCH) is used in the approach phase of flight.
State that RNP 0.3 navigation specification is used in all phases of flight except for oceanic/remote and final approach, primarily for helicopters.
State that RNAV 1, RNP 1 and RNP 0.3 may also be used in en-route phases of low-level instrument flight rule (IFR) helicopter flights.

Use of performance-based navigation (PBN)

Specific RNAV and RNP system functions

Recognise the definition of radius to fix (RF) leg.
Recognise the definition of a fixed radius transition (FRT).
State the importance of respecting the flight director guidance and the speed constraints associated with an RF procedure.
Explain the difference between a fly-by-turn and a fly-over.
State that the Aeronautical Radio, Incorporated (ARINC) 424 path terminators set the standards for coding the SIDs, STARs and instrument approach procedures (IAPs) from the official published government source documentation into the ARINC navigation database format.
State that the path terminators define a specific type of termination of the previous flight path.
Define the term ‘offset flight path’.

Performance-based navigation (PBN) operations

Performance-based navigation (PBN) principles

Define ‘path definition error’ (PDE).
Define ‘flight technical error’ (FTE) and state that the FTE is the error in following the prescribed path, either by the auto-flight system or by the pilot.
Define ‘navigation system error’ (NSE) and state that the accuracy of a navigation system may be referred to as NSE.
Define ‘total system error’ (TSE) and state that the geometric sum of the PDE, FTE and NSE equals the TSE.
State that navigation accuracy depends on the TSE.

On-board performance monitoring and alerting

State that on-board performance monitoring and alerting of flight technical errors is managed by on-board systems or flight crew procedures.
State that on-board performance monitoring and alerting of navigation system errors is a requirement of on-board equipment for RNP.
State that, dependent on the navigation sensor, the estimated position error (EPE) is compared with the required navigation specification.
Explain how a navigation system assesses the EPE.
Give an example of how the loss of the ability to operate in RNP airspace may be indicated by the navigation system.
State that on-board performance monitoring and alerting of path definition error is managed by gross reasonableness checks of navigation data.

Abnormal situations

State that abnormal and contingency procedures are to be used in case of loss of the PBN capability.

Database management

State that, unless otherwise specified in the operations documentation or acceptable means of compliance (AMCs), the navigational database must be valid for the current aeronautical information regulation and control (AIRAC) cycle.

Requirements of specific RNAV and RNP specifications

RNAV 10

State that RNAV 10 requires that aircraft operating in oceanic and remote areas be equipped with at least two independent and serviceable long-range navigation systems (LRNSs) comprising an INS, an inertial reference system (IRS)/flight management system (FMS) or a GNSS.

State that operators may extend their RNAV 10 navigation capability time by updating.

RNAV 5

State that manual data entry is acceptable for RNAV 5.

RNAV 1/RNAV 2/RNP 1/RNP 2

State that pilots must not fly an RNAV 1, RNAV 2, RNP 1 or RNP 2 standard instrument departure (SID) or standard instrument arrival (STAR) unless it is retrievable by route name from the on-board navigation database and conforms to the charted route.

State that the route may subsequently be modified through the insertion (from the database) or deletion of specific waypoints in response to ATC clearances.

State that the manual entry, or creation of new waypoints by manual entry, of either latitude and longitude or place/bearing/distance values is not permitted.

Required navigation performance approach (RNP APCH)

State that pilots must not fly an RNP APCH unless it is retrievable by procedure name from the on-board navigation database and conforms to the charted procedure.

State that an RNP APCH to LNAV minima is a non-precision IAP designed for two-dimensional approach operations.

State that an RNP APCH to lateral navigation (LNAV)/vertical navigation (VNAV) minima has lateral guidance based on GNSS and vertical guidance based on either SBAS or barometric vertical navigation (Baro-VNAV).

State that an RNP APCH to LNAV/VNAV minima may only be conducted with vertical guidance certified for the purpose.

Explain why an RNP APCH to LNAV/VNAV minima based on Baro-VNAV may only be conducted when the aerodrome temperature is within a promulgated range if the barometric input is not automatically temperature-compensated.

State that the correct altimeter setting is critical for the safe conduct of an RNP APCH using Baro-VNAV.

State that an RNP APCH to LNAV/VNAV minima is a three-dimensional operation.

State that an RNP APCH to localiser performance with vertical guidance (LPV) minima is a three-dimensional operation.

State that RNP APCH to LPV minima requires a final approach segment (FAS) data block.

State that RNP approaches to LPV minima require SBAS.

State that the FAS data block is a standard data format to describe the final approach path.

Required navigation performance authorisation required approach (RNP AR APCH)

State that RNP AR APCH requires authorisation.

Advanced required navigation performance (A-RNP)

State that A-RNP incorporates the navigation specifications RNAV 5, RNAV 2, RNAV 1, RNP 2, RNP 1 and RNP APCH.

070. OPERATIONAL PROCEDURES

GENERAL REQUIREMENTS

ICAO Annex 6

Definitions

Define the following: alternate aerodrome: flight time (aeroplanes); take-off alternate; en-route alternate; destination alternate.

Source: ICAO Annex 6, Part I, Chapter 1.

Applicability

State that Part I shall be applicable to the operation of aeroplanes by operators authorised to conduct international commercial air transport (CAT) operations.

Source: ICAO Annex 6, Part I, Chapter 2.

General

Explain the compliance with laws, regulations and procedures.

Source: ICAO Annex 6, Part I, Chapter 3.1; ICAO Annex 6, Part III, Section 2, Chapter 1.1.

State the condition(s) required for the establishment of a flight data analysis programme, and state what this programme is part of.

Source: ICAO Annex 6, Part I, Chapter 3.3

Explain what is a flight safety documents system.

Source: ICAO Annex 6, Part I, Chapter 3.3.

Explain what is maintenance release.

Source: ICAO Annex 6, Part I, Chapter 8.8; ICAO Annex 6 Part III, Section 2, Chapter 6.7

List and describe the lights to be displayed by aircraft.

Source: ICAO Annex 6, Part I, Appendix 1: 2. Navigation lights to be displayed in the air

Operational requirements

Applicability

State the operational regulations applicable to CAT and other activities (e.g. specialised operations (SPO)).

Source: Regulation (EU) No 965/2012 on air operations; Regulation (EU) No 1178/2011 on aircrew requirements

State the nature of CAT operations and exceptions.

Source: Regulation (EU) No 965/2012: Articles 1 and 5, points ORO.GEN5 'Scope' and CAT.GEN.100 'Competent authority'; Regulation (EU) 2018/1139: Article 2

General

Explain why CAT flights must meet the applicable operational requirements.

Source: Point ORO.GEN.105 'Competent authority' and related AMCs/GM;Point ORO.GEN.110 'Operator responsibilities' and related AMCs/GM

Define 'flight manual limitations - flight through the height velocity (HV) envelope'.

Explain the requirements about language used for crew communication and in the operations manual.

Source: Point CAT.GEN.MPA.120 'Common language'

Explain which are the operator requirements regarding the management system.

Source: Point ORO.GEN.200 'Management system'; AMCs/GM to ORO.GEN.205 'Contracted activities' and to ORO.GEN.220 'Record-keeping'

Explain which are the operator requirements regarding accident prevention and the flight safety programme.

Source: Point ORO.GEN.200 'Management system'; AMCs/GM to ORO.GEN.205 'Contracted activities', to ORO.GEN.220 'Record-keeping', and to ORO.AOC.130 'Flight data monitoring — aeroplanes'

Explain which are the regulations concerning the carriage of persons on an aircraft.

Source: Point CAT.GEN.MPA.165 'Method of carriage of persons'

Explain the operator's and commander's responsibility concerning portable electronic devices (PEDs).

Source: Point CAT.GEN.MPA.140 'Portable electronic devices'

Explain the operator's and commander's responsibility regarding admission in an aircraft of a person under the influence of drug or alcohol.

Source: Point CAT.GEN.MPA.170 'Alcohol and drugs'

Explain the regulations concerning the endangerment of safety.

Source: Point CAT.GEN.MPA.175 'Endangering safety'

List the documents to be carried on each flight.

Source: Point CAT.GEN.MPA.180 'Documents, manuals and information to be carried' and related AMCs/GM

Explain the operator's responsibility regarding manuals to be carried on board an aircraft.

Source: Point CAT.GEN.MPA.180 'Documents, manuals and information to be carried' and related AMCs/GM

List the additional information and forms to be carried on board an aircraft.

Source: Point CAT.GEN.MPA.180 'Documents, manuals and information to be carried on board an aircraft' and related AMCs/GM

List the copies of items of information to be retained on the ground by the operator.

Source: Point CAT.GEN.MPA.185 'Information to be retained on the ground'

Explain what responsibilies the operator and the commander have regarding the production of and access to records and documents.

Source: Point CAT.GEN.MPA.190 'Provision of documentation and records'

Operator certification and supervision

Explain what requirement has to be satisfied for the issue of an air operator certificate (AOC).

Source: Point ARO.OPS.100 'Issue of the air operator certificate'; Point ORO.GEN.210 'Personnel requirements'; Point ORO.AOC.100 'Application for an air operator certificate'

Explain what the rules applicable to air operator certification are.

Source: Point ORO.AOC.100 'Application for an air operator certificate'; Point ORO.AOC.105 'Operations specifications and privileges of an AOC holder'

Explain the conditions to be met for the issue or revalidation of an AOC.

Source: ARO.GEN.310 'Initial certification procedure-organisations'

Explain the contents and conditions of the AOC.

Source: Regulation (EU) No 956/2012, Appendix I 'AIR OPERATOR CERTIFICATE'

Operational procedures (except preparation for long-range flight)

Define the terms used for operational procedures.

Source: Point CAT.OP.MPA.106 'Use of isolated aerodromes - aeroplanes'; Point CAT.OP.MPA.107 'Adequate aerodrome'

State the operator's responsibilities regarding the use of air traffic services (ATS).

Source: Point CAT.OP.MPA.100 'Use of air traffic services'

State the operator's responsibilities regarding authorisation of aerodromes/heliports by the operator.

Source: Point CAT.OP.MPA.105 'Use of aerodromes and operating sites'; Point CAT.OP.MPA.106 'Use of isolated aerodromes—aeroplanes'; Point CAT.OP.MPA.107 'Adequate aerodrome'

Explain which elements must be considered by the operator when specifying aerodrome/heliport operating minima.

Source: Point CAT.OP.MPA.110 (a) and (c) 'Aerodrome operating minima', Point CAT.OP.MPA.115 'Approach flight technique - aeroplanes' , Point SPA.LVO.100 'Low visibility operations' and related AMCs/GM; Point SPA.LVO.110 'General operating requirements'

Explain what the operator's responsibilities are regarding departure and approach procedures.

Source: Point CAT.OP.MPA.125 'Instrument departure and approach procedures'

Explain which parameters should be considered in noise-abatement procedures.

Source: Point CAT.OP.MPA.130 'Noise abatement procedures — aeroplanes';

Explain which elements should be considered regarding routes and areas of operation.

Source: Point CAT.OP.MPA.135 'Routes and areas of operation — general'; Point CAT.OP.MPA.136 'Routes and areas of operation — single-engined aeroplanes'

Explain the requirements for flights in reduced vertical separation minima (RVSM) airspace.

Source: Point SPA.RVSM.100 'RVSM operations'; Point SPA.RVSM.105 'RVSM operational approval';Point SPA.RVSM.110 'RVSM equipment requirements' and AMC1 SPA.RVSM.110(a); Point SPA.RVSM.115 'RVSM height-keeping errors'

List the factors to be considered when establishing minimum flight altitude.

Source: Point CAT.OP.MPA.145 'Establishment of minimum flight altitudes' and related AMCs/GM; AMC1 CAT.OP.MPA.145(a); AMC1.1 CAT.OP.MPA.145(a)

Explain the requirements for carrying persons with reduced mobility.

Source: Point CAT.OP.MPA.155 'Carriage of special categories of passengers (SCPs)'

Explain the operator's responsibilities for the carriage of inadmissible passengers, deportees or persons in custody.

Source: Point CAT.OP.MPA.155 'Carriage of special categories of passengers (SCPs)'

Explain the requirements regarding passenger seating and emergency evacuation.

Source: Point CAT.OP.MPA.165 'Passenger seating' and related AMCs/GM

Detail the procedures for passenger briefing in respect of emergency equipment and exits.

Source: Point CAT.OP.MPA.170 'Passenger briefing'; AMC1 CAT.OP.MPA.170; AMC2 CAT.OP.MPA.170

State the flight preparation forms to be completed before flight.

Source: Point CAT.OP.MPA.175 'Flight preparation' and related AMCs/GM; AMC1 CAT.OP.MPA.175(a)

State the commander's responsibilities during flight preparation.

Source: Point CAT.OP.MPA.175 'Flight preparation'

State the rules for aerodrome/heliport selection.

Source: Point CAT.OP.MPA.180 'Selection of aerodromes — aeroplanes'; Point CAT.OP.MPA.181 'Selection of aerodromes and operating sites — helicopters'

Explain the planning minima for instrument flight rule (IFR) flights.

Source: Point CAT.OP.MPA.185 'Planning minima for IFR flights — aeroplanes'

Explain the rules for refuelling/defueling with passengers on board.

Source: Point CAT.OP.MPA.195 'Refuelling/defuelling with passengers embarking, on board or disembarking' and related AMCs; AMC1 CAT.OP.MPA.195; Point CAT.OP.MPA.200 'Refuelling/ defuelling with widecut fuel' and related AMCs; GM1 CAT.OP.MPA.200

Explain the 'crew members at station' policy.

Source: CAT.OP.MPA.210 'Crew members at stations' and related AMCs; AMC1 CAT.OP.MPA.210(b); GM1 CAT.OP.MPA.210

Explain the use of seats, safety belts and harnesses.

Source: Point CAT.OP.MPA.225 'Seats, safety belts and restraint systems'

Explain the requirements for securing passenger cabin and galley.

Source: Point CAT.OP.MPA.230 'Securing of passenger compartment and galley(s)'

Explain the commander's responsibility regarding smoking on board.

Source: Point CAT.OP.MPA.240 'Smoking on board'

State under which conditions a commander can commence or continue a flight regarding meteorological conditions.
Source: Point CAT.OP.MPA.245 'Meteorological conditions — all aircraft'; Point CAT.OP.MPA.246 'Meteorological conditions — aeroplanes'; Point CAT.OP.MPA.265 'Take-off conditions'
Explain the commander's responsibility regarding ice and other contaminants.
Source: Point CAT.OP.MPA.250 'Ice and other contaminants — ground procedures' and related AMCs/GM; Point CAT.OP.MPA.255 'Ice and other contaminants — flight procedures' and related AMCs/GM; GM1 CAT.OP.MPA.250 (a) to (l); GM2 CAT.OP.MPA.250 (a) to (f); GM3 CAT.OP.MPA.250 (a)(1) to (3); AMC1 CAT.OP.MPA.255 (a)
Explain the commander's responsibility regarding fuel to be carried and in-flight fuel management.
Source: Point CAT.OP.MPA.260 'Fuel and oil supply'; Point CAT.OP.MPA.280 'In-flight fuel management — aeroplanes'; Point CAT.OP.MPA.281 'In-flight fuel management — helicopters' and AMC1 CAT.OP.MPA.281
Detail the rules regarding carriage and use of supplemental oxygen for passengers and aircrew.
Source: Point CAT.OP.MPA.285 'Use of supplemental oxygen'; Point CAT.IDE.A.235 'Supplemental oxygen — pressurised aeroplanes' and related AMCs/GM

Flight Preperation

Explain the commander's responsibility regarding approach and landing.
Source: Point CAT.OP.MPA.300 'Approach and landing conditions' and AMC1 CAT.OP.MPA.300; Point CAT.OP.MPA.305 'Commencement and continuation of approach' and related AMCs/GM
Explain the circumstances under which a report shall be submitted.
Source: Point ORO.GEN.160 'Occurrence reporting' and related AMCs/GM

All-weather operations

Explain the operator's responsibility regarding aerodrome/heliport operating minima.
Source: Point CAT.OP.MPA.110 'Aerodrome operating minima' and related AMCs/GM; Point CAT.OP.MPA.115 'Approach flight technique - aeroplanes' and related AMCs/GM
Define the following terms: 'circling', 'low-visibility procedures', 'low-visibility take-off', 'visual approach'.
Source: Regulation (EU) No 965/2012, Annex I
Define the following terms: 'flight control system', 'fail-passive flight control system', 'fail-operational flight control system', 'fail-operational hybrid landing system'.
Source: Regulation (EU) No 965/2012, Annex I
Explain the general operating requirements for low-visibility operations.
Source: Point SPA.LVO.100 'Low visibility operations' and related AMCs; Point SPA.LVO.105 'LVO approval'; Point SPA.LVO.110 'General operating requirements'; Point SPA.LVO.115 'Aerodrome related requirements'
Define aerodrome/heliport considerations regarding low-visibility operations.
Source: SPA.LVO.115 'Aerodrome related requirements'
Explain the training and qualification requirements for flight crew to conduct low-visibility operations.
Source: Point SPA.LVO.120 'Flight crew training and qualifications' and related AMCs
Explain the operating procedures for low-visibility operations.
Source: Point SPA.LVO.125 'Operating procedures and AMC1 SPA.LVO.125
Explain the operator's and commander's responsibilities regarding minimum equipment for low-visibility operations.
Source: Point SPA.LVO.130 'Minimum equipment'
Explain the VFR operating minima.
Source: AMC12 CAT.OP.MPA.110 'Aerodrome operating minima — VFR OPERATIONS WITH OTHER-THAN-COMPLEX MOTOR-POWERED AIRCRAFT'
Aerodrome operating minima: explain under which conditions the commander can commence take-off.
Source: Point CAT.OP.MPA.110 'Aerodrome operating minima' and related AMCs/GM; Point SPA.LVO.110 'General operating requirements' and related AMCs/GM
Aerodrome operating minima: explain that take-off minima are expressed as visibility or runway visual range (RVR).
Source: Point CAT.OP.MPA.110 'Aerodrome operating minima'; AMC1 CAT.OP.MPA.110; AMC2 CAT.OP.MPA.110
Aerodrome operating minima: explain the take-off RVR value
depending on the aerodrome facilities.
Source: AMC1 CAT.OP.MPA.110 'Aerodrome operating minima', Table 1.A; AMC2 CAT.OP.MPA.110 'Aerodrome operating minima', Table 1.H
Aerodrome operating minima: explain the system minima for non-precision approach (NPA) (minimum descent altitude/height (MDA/H) and decision altitude/height (DA/H), not RVR).
Source: AMC3 CAT.OP.MPA.110 'Aerodrome operating minima' (Table 3: ILS/MLS/GLS; SRA 1NM; VOR; NDB); AMC6 CAT.OP.MPA.110 'Aerodrome operating minima'

Aerodrome operating minima: explain under which conditions a pilot can continue the approach below MDA/H or DA/H.
Source: Point CAT.OP.MPA.305 'Commencement and continuation of approach'; AMC1 CAT.OP.MPA.305(e)
Aerodrome operating minima: explain the lowest minima for precision approach category 1 (including single-pilot operations).
Source: AMC3 SPA.LVO.100 'Low visibility operations'
Aerodrome operating minima: explain the lowest minima for precision approach category 2 operations.
Source: AMC4 SPA.LVO.100 'Low visibility operations'
Aerodrome operating minima: explain the lowest minima for precision approach category 3 operations.
Source: AMC5 SPA.LVO.100 'Low visibility operations'
Aerodrome operating minima: explain the lowest minima for circling and visual approach.
Source: AMC7 CAT.OP.MPA.110 'Aerodrome operating minima'; AMC9 CAT.OP.MPA.110; AMC8 CAT.OP.MPA.110
Instruments and equipment
Explain which items do not require an equipment approval.
Source: Point CAT.IDE.A.100 'Instruments and equipment - general' and related GM, and point CAT.IDE.H.100 'Instruments and equipment - general'; Points CAT.IDE.A.105/CAT.IDE.H.105 'Minimum equipment for flight'
Explain the requirements regarding availability of spare electrical fuses.
Source: Point CAT.IDE.A.110 'Spare electrical fuses' and related GM
Explain the requirements regarding windshield wipers.
Source: Point CAT.IDE.A.120 'Equipment to clear windshield' and related AMCs
List the minimum equipment required for day and night VFR flights.
Source: Point CAT.IDE.A.125 'Operations under VFR by day' and related AMCs/GM
List the minimum equipment required for IFR flights.
Source: Point CAT.IDE.A.130 'Operations under IFR or at night — flight and navigational instruments and associated equipment' and related AMCs/GM; Point CAT.IDE.H.130 'Operations under IFR or at night — flight and navigational instruments and associated equipment' and related AMCs/GM
Explain the required additional equipment for single-pilot operations under IFR.
Source: Points CAT.IDE.A.135/CAT.IDE.H.135 'Additional equipment for single-pilot operation under IFR'
State the requirements for an altitude alerting system.
Source: Point CAT.IDE.A.140 'Altitude alerting system'
State the requirements for ground proximity warning system (GPWS)/terrain awareness and warning system (TAWS).
Source: Point CAT.IDE.A.150 'Terrain awareness warning system (TAWS)'
State the requirements for airborne collision avoidance system (ACAS).
Source: Point CAT.IDE.A.155 'Airborne collision avoidance system (ACAS)'
State the conditions under which an aircraft must be fitted with a weather radar.
Source: Points CAT.IDE.A.160/CAT.IDE.H.160 'Airborne weather detecting equipment'
State the circumstances under which a cockpit voice recorder (CVR) is compulsory (after 1998).
Source: Points CAT.IDE.A.185/CAT.IDE.H.185 'Cockpit voice recorder'
State the rules regarding the location, construction, installation, and operation of cockpit voice recorders (CVRs) (after 1998).
Source: Points CAT.IDE.A.185/CAT.IDE.H.185 'Cockpit voice recorder'
State the circumstances under which a flight data recorder (FDR) is compulsory (after 1998).
Source: Points CAT.IDE.A.190/CAT.IDE.H.190 'Flight data recorder'
State the rules regarding the location, construction, installation, and operation of flight data recorders (FDRs) (after 1998).
Source: Points CAT.IDE.A.190/CAT.IDE.A.190 'Flight data recorder' and related AMCs/GM
Explain the requirements about seats, seat safety belts, harnesses, and child-restraint devices.
Source: Points CAT.IDE.A.205/CAT.IDE.H.205 'Seats, seat safety belts, restraint systems and child restraint devices' and related AMCs/GM
Explain the requirements about 'Fasten seat belt' and 'No smoking' signs.
Source: Points CAT.IDE.A.210/CAT.IDE.H.210 'Fasten seat belt and no smoking signs'
Explain the requirements regarding internal doors and curtains.
Source: Point CAT.IDE.A.215 'Internal doors and curtains'
First-aid and emergency equipment
Explain the requirements regarding first-aid kits.
Source: Points CAT.IDE.A.220/CAT.IDE.H.220 'First-aid kit' and related AMCs/GM

Explain the requirements regarding emergency medical kits and first-aid oxygen.
Source: Point CAT.IDE.A.225 'Emergency medical kit'; AMC1 CAT.IDE.A.225; AMC2 CAT.IDE.A.225; AMC3 CAT.IDE.A.225; AMC4 CAT.IDE.A.225; GM1 CAT.IDE.A.225; Point CAT.IDE.A.230 'First-aid oxygen'
Detail the rules regarding crew protective breathing equipment.
Source: Point CAT.IDE.A.245 'Crew protective breathing equipment'; AMC1 CAT.IDE.A.245
Describe the type and location of handheld fire extinguishers.
Source: Points CAT.IDE.A.250/CAT.IDE.H.250 'Hand fire extinguishers' and related AMCs/GM
Describe the location of crash axes and crowbars.
Source: Point CAT.IDE.A.255 'Crash axe and crowbar'; AMC1 CAT.IDE.A.255
Specify the colours and markings used to indicate break-in points.
Source: Points CAT.IDE.A.260/CAT.IDE.H.260 'Marking of break-in points' and related AMCs/GM
Explain the requirements for means of emergency evacuation.
Source: Point CAT.IDE.A.265 'Means for emergency evacuation'
Explain the requirements for megaphones.
Source: Points CAT.IDE.A.270/CAT.IDE.H.270 'Megaphones' and related AMCs/GM
Explain the requirements for emergency lighting and marking.
Source: Points CAT.IDE.A.275/CAT.IDE.H.275 'Emergency lighting and marking
Explain the requirements for an emergency locator transmitter (ELT).
Source: Points CAT.IDE.A.280/CAT.IDE.H.280 'Emergency locator transmitter (ELT)' and related AMCs/GM
Explain the requirements for life jackets, life rafts, survival kits, and ELTs.
Source: Point CAT.IDE.A.285 'Flight over water'; Point CAT.IDE.A.305 'Survival equipment' Point CAT.IDE.H.280 'Emergency locator transmitter (ELT)'; Point CAT.IDE.H.290 'Life-jackets'; Point CAT.IDE.H.295 'Crew survival suits'; Point CAT.IDE.H.300 'Life-rafts, survival ELTs and survival equipment on extended overwater flights'
Explain the requirements for survival equipment.
Source: Points CAT.IDE.A.305/CAT.IDE.H.305 'Survival equipment'
Communication and navigation equipment
Explain the general requirements for communication and navigation equipment.
Source: Point CAT.IDE.A.325 'Headset' and related AMCs/GM
Explain why the radio-communication equipment must be able to send and receive on 121.5 MHz.
Source: Points CAT.IDE.A.330/CAT.IDE.H.330 'Radio communication equipment'
Explain the requirements regarding the provision of an audio selector panel.
Source: Points CAT.IDE.A.335/CAT.IDE.H.335 'Audio selector panel'
List the requirements for radio equipment when flying under VFR by reference to visual landmarks.
Source: Points CAT.IDE.A.340/CAT.IDE.H.340 'Radio equipment for operations under VFR over routes navigated by reference to visual landmarks'
List the requirements for communication and navigation equipment when operating under IFR or under VFR over routes not navigated by reference to visual landmarks.
Source: Points CAT.IDE.A.345/CAT.IDE.H.345 'Communication and navigation equipment for operations under IFR or under VFR over routes not navigated by reference to visual landmarks'
Explain what equipment is required to operate in airspace with reduced vertical separation minima (RVSM).
Source: Point SPA.RVSM.110 'RVSM equipment requirements'
Explain the conditions under which a crew member interphone system and public address system are mandatory.
Source: Points CAT.IDE.A.170/CAT.IDE.H.170 'Flight crew interphone system'; AMC1 CAT.IDE.A.170/CAT.IDE.H.170; Points CAT.IDE.A.175/CAT.IDE.H.175 'Crew member interphone system'; AMC1 CAT.IDE.A.175/CAT.IDE.H.175; Points CAT.IDE.A.180/CAT.IDE.H.180 'Public address system'; AMC1 CAT.IDE.A.180/CAT.IDE.H.180
Explain the requirements regarding the provision of a transponder. **Source: Points CAT.IDE.A.350/CAT.IDE.H.350 'Transponder'; AMC1 CAT.IDE.A.350/CAT.IDE.H.350**
Explain the requirements regarding the management of aeronautical databases.
Source: Point CAT.IDE.A.355 'Management of aeronautical databases'; AMC1 CAT.IDE.A.355 'Management of aeronautical databases - AERONAUTICAL DATABASES'
Flight crew
Explain the requirement regarding flight crew composition and in-flight relief.
Source: Point ORO.FC.100 'Composition of flight crew; AMC1 ORO.FC.100(c); Point ORO.FC.105 'Designation as pilot-in-command/commander'; AMC1 ORO.FC.105(b)(2);(c); GM1 ORO.FC.105 (b)(2); AMC1 ORO.FC.105(c); Point ORO.FC.110 'Flight engineer'; Point ORO.FC.115 'Crew resource management (CRM) training'; Point ORO.FC.200 'Composition of flight crew'; AMC1 ORO.FC.200(a); Point ORO.FC.A.201 'In-flight relief of flight crew members'; Point ORO.FC.202 Single-pilot operations under IFR or at night

Explain the requirement for conversion training and checking.
Source: Point ORO.FC.120 'Operator conversion training'; Point ORO.FC.145 'Provision of training'; Point ORO.FC.220 'Operator conversion training and checking'; and related AMCs/GM
Explain the requirement for differences training and familiarisation training.
Source: Point ORO.FC.125 'Differences training and familiarisation training'; AMC1 ORO.FC.125
Explain the conditions for upgrade from co-pilot to commander.
Source: Point ORO.FC.205 'Command course'
Explain the minimum qualification requirements to operate as a commander.
Source: Point ORO.FC.A.250 'Commanders holding a CPL(A)'
Explain the requirement for recurrent training and checking.
Source: Point ORO.FC.230 'Recurrent training and checking'
Explain the requirement for a pilot to operate on either pilot's seat.
Source: Point ORO.FC.235 'Pilot qualification to operate in either pilot's seat'; AMC1 ORO.FC.235(d); GM1 ORO.FC.235(f);(g)
Explain the minimum recent experience requirements for the commander and the co-pilot.
Source: Point FCL.060 'Recent experience'; AMC1 FCL.060(b)(1); GM1 FCL.060(b)(1)
Specify the route and aerodrome/heliport knowledge required for a PIC/commander.
Source: Point ORO.FC.105 'Designation as pilot-in-command/ commander'; AMC1 ORO.FC.105(b)(2);(c); GM1 ORO.FC.105(b)(2); AMC1 ORO.FC.105(c)
Explain the requirement to operate on more than one aircraft type or variant.
Source: Point ORO.FC.140 'Operation on more than one type or variant'; Point ORO.FC.240 'Operation on more than one type or variant'; AMC1 ORO.FC.240(a)(1)
Explain that when a flight crew member operates both helicopters and aeroplanes, the operations are limited to one of each type.
Source: Point ORO.FC.240 'Operation on more than one type or variant'
Explain the requirement(s) for training records.
Source: Point ORO.MLR.115 'Record-keeping'
Explain the crew members' responsibilities in the execution of their duties, and define the commander's authority.
Source: Point CAT.GEN.MPA.100 'Crew responsibilities; Point CAT.GEN.MPA.105 'Responsibilities of the commander; Point CAT.GEN.MPA.110 'Authority of the commander'
Explain the operator's and commander's responsibilities regarding persons on board, admission to the flight crew compartment and carriage of unauthorised persons or cargo.
Source: Point CAT.GEN.MPA.135 'Admission to the flight crew compartment; Point CAT.GEN.MPA.165 'Method of carriage of persons; Point CAT.GEN.MPA.105 'Responsibilities of the commander'
Explain the requirements for the initial operator's crew resource management (CRM) training.
Source: Point ORO.FC.215 'Initial operator's crew resource management (CRM) training'
Cabin crew/crew members other than flight crew
Explain who is regarded as cabin crew member.
Source: Regulation (EU) No 965/2012, Annex I 'Definitions'
Detail the requirements regarding the number and composition of cabin crew.
Source: Point ORO.CC.100 'Number and composition of cabin crew; AMC1 ORO.CC.100; GM1 ORO.CC.100; Point ORO.CC.205 'Reduction of the number of cabin crew during ground operations and in unforeseen circumstances'
Explain the conditions and the additional conditions for assignment to duties.
Source: Point ORO.CC.110 'Conditions for assignment to duties; Point ORO.CC.210 'Additional conditions for assignment to duties; GM1 ORO.CC.210(d)
Explain the requirements regarding senior cabin crew members.
Source: Point ORO.CC.200 'Senior cabin crew member; AMC1 ORO.CC.200(c);(d);(e)
Explain the conditions for operating on more than one aircraft type or variant.
Source: Point ORO.CC.250 'Operation on more than one aircraft type or variant; AMC1 ORO.CC.250(b); GM1 ORO.CC.250
Explain what is the operator's responsibility regarding the distinction between cabin crew members and additional crew members.
Source: Point CAT.GEN.MPA.115 'Personnel or crew members other than cabin crew in the passenger compartment'
Flight and duty time limitations and rest requirements
Explain the definitions used for the regulation of flight time limitations.
Source: Point ORO.FTL.100 'Scope'; Point ORO.FTL.105 'Definitions' (values of Table 1 excluded)
Explain the flight and duty time limitations.
Source: Point ORO.FTL.200 'Home base'; Point ORO.FTL.210 'Flight times and duty periods'

Explain the requirements regarding the maximum daily flight duty period.
Source: Point ORO.FTL.205 'Flight duty period (FDP)'; Point ORO.FTL.205(b) 'Basic maximum daily FDP' (use of the tables but not memorisation)
Explain the requirements regarding rest periods.
Source: Point ORO.FTL.235 'Rest periods'
Explain the possible extension of flight duty period due to in-flight rest.
Source: Point ORO.FTL.205 'Flight duty period (FDP)'; Point ORO.FTL.205(e) 'Maximum daily FDP with the use of extensions due to in-flight rest'
Explain that it is the captain's discretion to extend flight duty in case of unforeseen circumstances in actual flight operations.
Source: Point ORO.FTL.205 'Flight duty period (FDP)'; Point ORO.FTL.205(f) 'Unforeseen circumstances in flight operations - commander's discretion'
Explain the requirement regarding standby.
Source: Point ORO.FTL.225 'Standby and duties at the airport'
Long-range flights
Flight management
Minimum time routes: define and interpret minimum time route (route that gives the shortest flight time from departure to destination adhering to all ATC and airspace restrictions).
Source: N/A
State the circumstances in which a take-off alternate must be selected.
Source: Point CAT.OP.MPA.180 'Selection of aerodromes — aeroplanes; Point CAT.OP.MPA.181 'Selection of aerodromes and operating sites — helicopters'
State the maximum flight distance of a take-off alternate for:
— two-engined aeroplanes;
— ETOPS-approved aeroplanes;
— three- or four-engined aeroplanes.
Source: Point CAT.OP.MPA.180 'Selection of aerodromes — aeroplanes'; Point CAT.OP.MPA.181 'Selection of aerodromes and operating sites — helicopters'
State the factors to be considered in the selection of a take-off alternate.
Source: Point CAT.OP.MPA.185 'Planning minima for IFR flights — aeroplanes'; Point CAT.OP.MPA.186 'Planning minima for IFR flights — helicopters'
State when a destination alternate need not be selected.
Source: Point CAT.OP.MPA.180 'Selection of aerodromes — aeroplanes'; Point CAT.OP.MPA.181 'Selection of aerodromes and operating sites — helicopters'
State when two destination alternates must be selected.
Source: Point CAT.OP.MPA.180 'Selection of aerodromes — aeroplanes'; Point CAT.OP.MPA.181 'Selection of aerodromes and operating sites — helicopters'
State the factors to be considered in the selection of a destination alternate aerodrome.
Source: Point CAT.OP.MPA.185 'Planning minima for IFR flights-aeroplanes'; Point CAT.OP.MPA.186 'Planning minima for IFR flights-helicopters'
State the factors to be considered in the selection of an enroute alternate aerodrome.
Source: Point CAT.OP.MPA.185 'Planning minima for IFR flights — aeroplanes'
Transoceanic and polar flights
(ICAO Doc 7030 'Regional Supplementary Procedures — North Atlantic Operations and Airspace Manual')
According to ICAO Doc 7030, explain that special rules apply to the North Atlantic (NAT) Region, and crews need to be specifically trained before flying in this area.
Source: NAT 007, 1.3.8 Crew Training
Describe the possible indications of navigation system degradation, including any system-generated warning.
Source: NAT 007, Chapter 12 Procedures in the event of navigation system degradation or failure
Describe by what emergency means course and inertial navigation system (INS) can be cross-checked in the case of three navigation systems and two navigation systems.
Source: NAT 007, Chapter 12 Procedures in the event of navigation system degradation or failure
Describe the general ICAO procedures applicable in NAT airspace if the aircraft is unable to continue the flight in accordance with its air traffic control (ATC) clearance.
Source: NAT 007, 13.2 General procedures
Describe the ICAO procedures applicable in NAT airspace in case of radio-communication failure.
Source: NAT 007, 6.6 HF Communications failure

Describe the recommended initial action if an aircraft is unable to obtain a revised ATC clearance.
Source: NAT 007, Chapter 13 Special procedures for in-flight contingencies
Describe the subsequent action for aircraft able to maintain assigned flight level and for aircraft unable to maintain assigned flight level.
Source: NAT 007, Chapter 13 Special procedures for in-flight contingencies
Describe determination of tracks and courses for random routes in NAT airspace.
Source: ICAO Doc 7030, NAT 2.1.9.1 General; NAT 007, 2.1.3; NAT 007, Chapter 4 Flight Planning
Specify the method by which planned tracks are defined (by latitude and longitude) in the NAT airspace: when operating predominately in an east–west direction south of 70°N, and when operating predominately in an east–west direction north of 70°N.
Source: ICAO Doc 7030, NAT 2.1.9 Route; NAT 007, Chapter 4 (Flights Planning on Random Route Segments in a Predominantly East - West Direction)
State the maximum flight time recommended between significant points on random routes.
Source: ICAO Doc 7030, NAT 2.1.9 Route; NAT 007, Chapter 4 (Flights Planning on Random Route Segments in a Predominantly East - West Direction and Predominantly North - South Direction)
Specify the method by which planned tracks for random routes are defined for flights operating predominantly in a north–south direction.
Source: ICAO Doc 7030, NAT 2.1.9 Route; NAT 007, Chapter 4 (Flights Planning on Random Routes in a Predominantly North - South Direction)
Describe how the desired random route must be specified in the ATC flight plan.
Source: NAT 007, 4.2 Flight planning requirements on specific routes
Describe what precautions can be taken when operating in the area of compass unreliability as a contingency against INS failure.
Source: NAT 007, Chapter 12 Procedures in the event of navigation system degradation or failure (not including detailed information on route structures and their coordinates); NAT 007, Chapter 8 (Master document - position plotting)
North Atlantic High Level Airspace (NAT HLA)
NAT Region North Atlantic Operations and Airspace Manual (NAT Doc 007 Version 2017-1 and NAT Doc 7030)
State the lateral dimensions (in general terms) and vertical limits of the NAT HLA.
Source: NAT 007, 17.1 GENERAL: 17.1.1 and 17.1.2
Define the following acronyms: LRNS, MASPS, NAT HLA, OCA, OTS, PRM, RVSM, SLOP, and WATRS.
Source: NAT 007, Glossary of Terms
State the NAT HLA operations.
Source: NAT 007, 1.1.2; 1.1.3; 1.1.5; 1.1.6; 1.1.7; 1.2.1; 1.2.2; 1.3.1; 1.3.2; 1.3.6; 1.3.7; 1.3.8
Describe the routes for aircraft with only one long-range navigation system (LRNS).
Source: NAT 007, 1.4.1
Describe the routes for aircraft with short-range navigation equipment only.
Source: NAT 007, 1.4.2; 1.4.3
Explain why the horizontal (i.e. latitudinal and longitudinal) and vertical navigation performance of operators within NAT HLA is monitored on a continual basis.
Source: NAT 007, 1.9.1
Describe the organised track system (OTS).
Source: NAT 007, 2.1 GENERAL; 2.2 Construction of the organised track system (OTS)
State the OTS changeover periods.
Source: NAT 007, 2.4 OTS Changeover periods
Describe the NAT track message.
Source: NAT 007, 2.3 The NAT track message
Illustrate routes between northern Europe and the Spain/Canaries/Lisbon flight information region (FIR) (T9, T13 and T16) within NAT HLA.
Describe the function of the North American Routes (NARs) and Shannon Oceanic Transition Area (SOTA) and Northern Oceanic Transition Area (NOTA).
Source: NAT 007, 3.3 Route structures adjacent to the NAT HLA
State that all flights should plan to operate on great-circle tracks joining successive significant waypoints.
Source: NAT 007, 4.1.3
State that during the hours of validity of the OTS, operators are encouraged to plan flights: — in accordance with the OTS; — or along a route to join or leave an outer track of the OTS; — or on a random route to remain clear of the OTS, either laterally or vertically.
Source: NAT 007, 4.1.4

State which flight levels are available on OTS tracks during OTS periods.
Source: NAT 007, 4.1.10; 4.1.11 and 4.1.12 (dates not required)
State which flight levels are to be planned on random tracks or outside OTS periods.
Source: NAT 007, 4.1.13
Selection of cruising altitude. Specify the appropriate cruising levels for normal long-range IFR flights and for those operating on the North Atlantic OTS.
Source: NAT 007, Chapter 4 Flight Planning - Flight Levels; SERA
Oceanic ATC clearances. State that it is recommended that pilots should request their oceanic clearance at least 40 minutes prior to the oceanic entry point estimated time of arrival (ETA).
Source: NAT 007, 5.1.2
State that pilots should notify the oceanic area control centre (OAC) of the maximum acceptable flight level possible at the boundary.
Source: NAT 007, 5.1.3
State that at some aerodromes which are situated close to oceanic boundaries, the oceanic clearance must be obtained before departure.
Source: NAT 007, 5.1.5
State that if an aircraft, which would normally be RVSM- or NAT HLA-approved, encounters, whilst en-route to the NAT Oceanic Airspace, a critical in-flight equipment failure, or at dispatch is unable to meet the MEL requirements for RVSM or NAT HLA approval of the flight, then the pilot must advise ATC at initial contact when requesting oceanic clearance.
Source: NAT 007, 5.1.6
State that after obtaining and reading back the clearance, the pilot should monitor the forward estimate for oceanic entry, and if this changes by 3 minutes or more, unless providing position reports via automatic dependent surveillance — contract (ADS-C), the pilot must pass a revised estimate on to ATC.
Source: NAT 007, 5.1.7
State that pilots should pay particular attention when the issued clearance differs from the flight plan as a significant proportion of navigation errors investigated in the NAT Region involve aircraft which have followed their flight plan rather than the differing clearance.
Source: NAT 007, 5.1.8
State that if the entry point of the oceanic route for which the flight is cleared differs from that originally requested or the oceanic flight level differs from the current flight level, the pilot is responsible for requesting and obtaining the necessary domestic reclearance.
Source: NAT 007, 5.1.9
State that there are three elements to an oceanic clearance: route, Mach number, and flight level, and that these elements serve to provide for the three basic elements of separation: lateral, longitudinal, and vertical.
Source: NAT 007, 5.1.1
Communications and position-reporting procedures
State that pilots communicate with OACs via aeradio stations staffed by communicators who have no executive ATC authority.
Source: NAT 007, 6.1.1
State that messages are relayed from the ground station to the air traffic controllers of the relevant OAC for action.
Source: NAT 007, 6.1.1
State that frequencies from the lower HF bands tend to be used for communications during night-time and those from the higher bands during daytime. Generally, in NAT, frequencies of less than 7 MHz are utilised at night and frequencies greater than 8 MHz are utilised during the day. When initiating contact with an aeradio station, the pilot should state the HF frequency in use.
Source: NAT 007, 6.1.4 and 6.1.7
State that since oceanic traffic typically communicates with ATC through aeradio facilities, a satellite communication (SATCOM) call, made due to unforeseen inability to communicate by other means, should be made to such a facility rather than the ATC centre, unless the urgency of the communication dictates otherwise.
Source: NAT 007, 6.1.17
State that an air-to-air VHF frequency has been established for worldwide use when aircraft are out of range of VHF ground stations which utilise the same or adjacent frequencies. This frequency, 123.45 MHz, is intended for pilot-to-pilot exchanges of operationally significant information.
Source: NAT 007, 6.2.2
State that any pilot, who provides position reports via data link and encounters significant meteorological phenomena (such as moderate/severe turbulence or icing, volcanic ash or thunderstorms), should report this information.
Source: NAT 007, 6.5.2

State that all turbine-engined aeroplanes having a maximum certified take-off mass exceeding 5 700 kg or authorised to carry more than 19 passengers are required to carry and operate airborne collision avoidance system (ACAS) II in the NAT Region.

Source: NAT 007, 6.9.1

State that even with the growing use of data-link communications, a significant volume of NAT air–ground communications are conducted using voice on single sideband (SSB) HF frequencies. To support air–ground ATC communications in the North Atlantic Region, 24 HF frequencies have been allocated, in bands ranging from 2.8 to 18 MHz.

Source: NAT 007, 6.1.3

Application of the Mach number technique (NAT HLA)

State that practical experience has shown that when two or more turbojet aircraft, operating along the same route at the same flight level, maintain the same Mach number, they are more likely to maintain a constant time interval between each other than when using other methods.

Source: NAT 007, 7.2.1

State that after leaving oceanic airspace, pilots must maintain their assigned Mach number in domestic controlled airspace unless and until the appropriate ATC unit authorises a change.

Source: NAT 007, 7.4.1

North Atlantic High Level Airspace (NAT HLA) flight operation and navigation procedures

NAT HLA flight operation and navigation procedures.

State that the pre-flight procedures for any NAT HLA flight must include a Universal Time Coordinated (UTC) time check.

Source: NAT 007, 8.2.2

Describe the function and use of the master document.

Source: NAT 007, 8.2.5 to 8.2.9

State the requirements for position plotting.

Source: NAT 007, 8.2.10 to 8.2.13

Describe the pre-flight procedures for:

— the alignment of IRS;

— the satellite navigation availability prediction
programme for flights using global navigation satellite
long-range navigation system (GNSS LRNS);

— loading of initial waypoints; and

— flight plan check.

Source: NAT 007, 8.3.2 to 8.3.5; 8.3.6 to 8.3.8; 8.3.13 to 8.3.17

Describe the strategic lateral offset procedure (SLOP) and state that along a route or track there will be three positions that an aircraft may fly: centre line, or 1 or 2 miles right.

Source: NAT 007, 8.5.1 to 8.5.5

State that RNAV 10 retains the RNP 10 designation, as
specified in the Performance-based Navigation Manual
(ICAO Doc 9613), 1.2.3.5. (ICAO Doc 7030, NAT Chapter 4).

Source: NAT 007, 1.3.4

State that both aircraft and operators must be RNP 10- or
RNP 4-approved by the State of the Operator or the State of Registry, as appropriate.

Source: NAT 007, 1.3.4

State that RNP 10 is the minimum navigation specification for the application of 93 km (50 NM) lateral separation.

Source: NAT 007, 1.3.4 and 4.1.18

Reduced vertical separation minima (RVSM) flight in NAT HLA State the altimeter cross-check to be performed before entering NAT HLA.

Source: NAT 007, 9.1.10

State the altimeter cross-check to be performed when entering and flying in NAT HLA.

Source: NAT 007, 9.1.12

State that pilots not using controller–pilot data-link communications (CPDLC)/ADS-C always report to ATC immediately on leaving the current cruising level and on reaching any new cruising level.

Source: NAT 007, 9.1.15

State that flight crew should report when a 300-ft deviation or more occurs.

Source: NAT 007, 11.3.4 and 11.3.6

Navigation planning procedures

List the factors to be considered by the commander before commencing the flight.

Source: NAT 007, 8.3 Pre-flight procedures, Navigation system degradation (NAT Doc 007, Chapter 12)

Navigation system degradation (NAT Doc 007, Chapter 12)
For this part, consider aircraft equipped with only two operational LRNSs and state the requirements for the following situations:
— one system fails before take-off;
— one system fails before the OCA boundary is reached;
— one system fails after the OCA boundary is crossed;
and
— the remaining system fails after entering NAT HLA.
Source: NAT 007, 12.2
Special procedures for in-flight contingencies
(NAT Doc 007, Chapter 13)
State the general procedures and also state that the general concept of these NAT in-flight contingency procedures is, whenever operationally feasible, to offset the assigned route by 15 NM and climb or descend to a level which differs fromthose normally used by 500 ft if below FL 410 or by 1 000 ft if above FL 410.
Source: NAT 007, 13.1 and 13.2
State all the factors which may affect the direction of turn
including:
— direction to an alternate aerodrome;
— terrain clearance;
— levels allocated on adjacent routes or tracks and any
known SLOP offsets adopted by other nearby traffic.
Source: NAT 007, 13.3.2
State that if the deviation around severe weather is to be greater than 10 NM, the assigned flight level must be changed by plus/minus 300 ft depending on the followed track and the direction of the deviation.
Source: NAT 007, 13.4
Extended-range operations with two-engined aeroplanes
(ETOPS)
State that ETOPS approval is part of an AOC.
Source: Point SPA.ETOPS.100 'ETOPS'; Point SPA.ETOPS.105 'ETOPS operational approval'
State that prior to conducting an ETOPS flight, an operator shall ensure that a suitable ETOPS en-route alternate is available, within either the approved diversion time or a diversion time based on the MEL-generated serviceability status of the aeroplane, whichever is shorter.
Source: Point SPA.ETOPS.110 'ETOPS en-route alternate
aerodrome'
State the requirements for take-off alternate.
Source: Point CAT.OP.MPA.180 'Selection of aerodromes - aeroplanes'
State the planning minima for ETOPS en-route alternate.
Source: Point SPA.ETOPS.115 'ETOPS en-route alternate aerodrome planning minima'
Navigation-planning procedures. -Describe the operator's responsibilities concerning ETOPS routes.
Source: Point CAT.OP.MPA.135 'Routes and areas of operation — general'; Point CAT.OP.MPA.145 'Establishment of minimum flight altitudes'; Point CAT.OP.MPA.150 'Fuel policy'
Selection of a route. Describe the limitations on extended-range operations with two-engined aeroplanes with and without ETOPS approval.
Selection of alternate aerodrome.
State the maximum flight distance of a take-off alternate for:
- two-engined aeroplanes;
- ETOPS-approved aeroplanes;
- three- or four-engined aeroplanes.
Source: Point CAT.OP.MPA.180 'Selection of aerodromes - aeroplanes'
State the maximum distance from an adequate aerodrome for two-engined aeroplanes without an ETOPS approval.
Source: Point CAT.OP.MPA.140 'Maximum distance from an adequate aerodrome for two-engined aeroplanes without an ETOPS approval'
State the requirement for alternate aerodrome accessibility check for ETOPS operations.
SPECIAL OPERATIONAL PROCEDURES AND HAZARDS (GENERAL ASPECTS)
Operations manual
(Points ORO.MLR.100, ORO.MLR.101 and related AMCs/GM)
Operating procedures
Explain the general rules for the operations manual.
Source: Point ORO.MLR.100 'Operations manual — general'; AMC1 ORO.MLR.100

Explain the structure and subject headings of the operations manual.
Source: Point ORO.MLR.101 'Operations manual — structure for commercial air transport'; GM1 ORO.MLR.100(k) 'Operations manual — general'
Explain the requirements for a journey log or equivalent.
Source: Point ORO.MLR.110 'Journey log'; AMC1 ORO.MLR.110
Describe the requirements regarding the operational flight plan.
Source: Point ORO.MLR.115 'Record-keeping'
Explain the requirements for document-storage periods.
Source: Point ORO.MLR.115 'Record-keeping'; AMC1 ORO.MLR.115; GM1 ORO.MLR.115(c);(d)
Explain that all non-type-related operational policies, instructions and procedures required for a safe operation are included in Part A of the operations manual.
Source: Point ORO.MLR.101 'Operations manual — structure for commercial air transport; AMC3 ORO.MLR.100 'Operations manual — general' (main topics in Part A, e.g. General/Basic, etc.)
State that the following items are included into Part A:
— de-icing and anti-icing on the ground;
— adverse and potentially hazardous atmospheric conditions;
— wake turbulence;
— incapacitation of crew members;
— use of the minimum equipment list (MEL) and configuration deviation list(s) (CDL);
— security;
— handling of accidents and occurrences.
Source: Point ORO.MLR.101 'Operations manual — structure for commercial air transport'; AMC3 ORO.MLR.100 'Operations manual — general'
State that the following items are included into Part A:
— altitude alerting system procedures;
— ground proximity warning system procedures;
— policy and procedures for the use of traffic alert and collision avoidance system (TCAS)/airborne collision avoidance system (ACAS).
Source: Point ORO.MLR.101 'Operations manual — structure for commercial air transport'; AMC3 ORO.MLR.100 'Operations manual — general'
State that rotor downwash is included into Part A.
Source: Point ORO.MLR.101 'Operations manual — structure for commercial air transport'; AMC3 ORO.MLR.100 'Operations manual — general'
Aeroplane/helicopter operating matters — type-related
State that all type-related instructions and procedures required for a safe operation are included in Part B of the operations manual. They take account of any differences between types, variants or individual aircraft used by an operator.
Source: Point ORO.MLR.101 'Operations manual — structure for commercial air transport'
State that the following items are included into Part B:
— emergency procedures;
— configuration deviation list (CDL);
— minimum equipment list (MEL);
— emergency evacuation procedures.
Source: Point ORO.MLR.101 'Operations manual — structure for commercial air transport'; AMC3 ORO.MLR.100 'Operations manual — general'
Minimum equipment list (MEL) and master minimum equipment list (MMEL)
Describe the following terms: 'commencement of flight', 'inoperative', 'MEL', 'MMEL', 'rectification interval'.
Source: GM1 ORO.MLR.105(a) 'Minimum equipment list'; CS-MMEL; GM2 ORO.MLR.105(d)(3)
Explain the relation between MMEL and MEL.
Source: Point ORO.MLR.100 'Operations manual — general'; Point ORO.MLR.105 'Minimum equipment list';AMC1 ORO.MLR.105(j);(g) GM1 ORO.MLR.105(j)
Define the 'extent of the MEL'.
Source: AMC2 ORO.MLR.105(d)(3) 'Minimum equipment list'
Explain the responsibilities of the operator and the competent authority with regard to MEL and MMEL.
Source: Point ORO.MLR.100 'Operations manual — general'; Point ORO.MLR.105 'Minimum equipment list'; AMC1 ORO.MLR.105(c); GM1 ORO.MLR.105(d)(3)

Explain the responsibilities of the flight crew members with regard to MEL.
Source: Points CAT.IDE.A.105/CAT.IDE.H.105 'Minimum equipment for flight'
Explain the responsibilities of the commander with regard to MEL.
Source: Point CAT.OP.MPA.175 'Flight preparation'; Point CAT.IDE.A.105/CAT.IDE.H.105 'Minimum equipment for flight'

Icing conditions

On ground de-icing/anti-icing procedures, types of de-icing/anti-icing fluids

Define the following terms: 'anti-icing', 'de-icing', 'one-step de-icing/anti-icing', 'two-step de-icing/anti-icing', 'holdover time'.
Source: ICAO Doc 9640 'Manual of Aircraft Ground Deicing/Anti-icing Operations', Glossary
Describe 'the clean aircraft concept' as presented in the relevant chapter of ICAO Doc 9640.
Source: ICAO Doc 9640 'Manual of Aircraft Ground De-icing/Anti-icing Operations', Chapter 2
List the types of de-icing/anti-icing fluids available.
Source: ICAO Doc 9640 'Manual of Aircraft Ground Deicing/Anti-icing Operations', Chapter 4, 4.1
Explain the procedure to be followed when an aeroplane has exceeded the holdover time.
Source: ICAO Doc 9640 'Manual of Aircraft Ground Deicing/Anti-icing Operations', Chapter 4, 4.9
Interpret the guidelines for fluid holdover times and list the factors which can reduce the fluid protection time.
Source: ICAO Doc 9640 'Manual of Aircraft Ground Deicing/Anti-icing Operations', Chapter 5: 5.1, 5.2 and Attachment (5 tables)
Explain how the pre-take-off check, which is the responsibility of the pilot-in-command, ensures that the critical surfaces of the aircraft are free of ice, snow, slush or frost just prior to take-off. This check shall be accomplished as close to the time of take-off as possible and is normally made from within the aeroplane by visually checking the wings.
Source: ICAO Doc 9640 'Manual of Aircraft Ground Deicing/Anti-icing Operations', Chapter 6, 6.4
Explain why an aircraft has to be treated symmetrically.
Source: ICAO Doc 9640 'Manual of Aircraft Ground Deicing/Anti-icing Operations', Chapter 11
Explain why an operator shall establish procedures to be followed when ground de-icing and anti-icing and related inspections of the aircraft are necessary.
Source: ICAO Doc 9640 'Manual of Aircraft Ground Deicing/Anti-icing Operations', Chapter 1: Introduction 1.1 to 1.6
Explain why a commander shall not commence take-off unless the external surfaces are clear of any deposit which might adversely affect the performance or controllability of the aircraft except as permitted in the flight manual.
Source: ICAO Doc 9640 'Manual of Aircraft Ground De-icing/Antiicing Operations';Point CAT.OP.MPA.250 'Ice and other contaminants — ground procedures'
Explain the requirements for operations in icing conditions.
Source: Point CAT.OP.MPA.250 'Ice and other contaminants — ground procedures'; Point CAT.OP.MPA.255 'Ice and other contaminants — flight procedures'; Point CAT.IDE.A.165 'Additional equipment for operations in icing conditions at night'; Point CAT.IDE.H.165 'Additional equipment for operations in icing conditions at night'
Explain why safety must come before commercial pressures in relation to de-icing and anti-icing of aircraft. (Consider time and financial cost versus direct and indirect effects of incident/accident).
Source: N/A

Procedure to apply in case of performance deterioration, on ground/in flight

Explain that the effects of icing are wide-ranging,unpredictable and dependent upon individual aircraft design. The magnitude of these effects is dependent upon many variables, but the effects can be both significant and dangerous.
Source: ICAO Doc 9640 'Manual of Aircraft Ground Deicing/Anti-icing Operations', Chapter 1
Explain that in icing conditions, for a given speed and a given angle of attack, wing lift can be reduced by as much as 30 % and drag increased by up to 40 %. State that these changes in lift and drag will significantly increase stall speed, reduce controllability, and alter flight characteristics.
Source: ICAO Doc 9640 'Manual of Aircraft Ground Deicing/Anti-icing Operations', Chapter 1
Explain that ice on critical surfaces and on the airframe may also break away during take-off and be ingested into engines, possibly damaging fan and compressor blades.
Source: ICAO Doc 9640 'Manual of Aircraft Ground Deicing/Anti-icing Operations', Chapter 1
Explain that ice forming on pitot tubes and static ports or on angle-of-attack vanes may give false altitude, airspeed, angle-of-attack and engine-power information for air-data systems.

Source: ICAO Doc 9640 'Manual of Aircraft Ground Deicing/ Anti-icing Operations', Chapter 1
Explain that ice, frost and snow formed on the critical surfaces on the ground can have a totally different effect on aircraft flight characteristics than ice, frost and snow formed in flight.
Source: ICAO Doc 9640 'Manual of Aircraft Ground De-icing/Anti-icing Operations', Chapter 1
Explain that flight in known icing conditions is subject to limitations that are contained in Part B of the operations manual.
Source: AMC4 ORO.MLR.100 'Operations manual —general'
Explain where procedures and performances regarding flight in expected or actual icing conditions can be found.
Source: AMC4 ORO.MLR.100 'Operations manual —general'
Bird-strike risk
Bird-strike risk and avoidance
Explain that the presence of birds that constitute a potential hazard to aircraft operations is part of the pre-flight information.
Source: ICAO Annex 15, 8.1 Pre-flight information
Explain how information concerning the presence of birds observed by aircrews is made available to the aeronautical information service (AIS) for distribution as the circumstances dictate.
Source: ICAO Annex 15, Chapter 8
Explain that the Aeronautical Information Publication (AIP) Section En-route (ENR) 5.6 contains information regarding bird migrations.
Source: ICAO Annex 15, Appendix 1
Explain significant data regarding bird strikes contained in ICAO Doc 9137 'Airport Services Manual'.
Source: ICAO Doc 9137 'Airport Services Manual', Chapter 1
Explain why birds constitute a hazard to aircraft (damage to probes, sensors, engines, windscreens, airframes, degradation in vision, etc.).
Source: N/A, though history in ICAO Doc 9137, Chapter 1.
For more information, refer to the EGAST safety promotion leaflet 'Bird strike, a European risk with local specificities', available at:
www.easa.europa.eu/system/files/dfu/EGAST_GA6-birdstrikes-final.pdf
Define the commander's responsibilities regarding the reporting of bird hazards and bird strikes.
Source: Point CAT.GEN.MPA.105 'Responsibilities of the commander'
State that birds tend to flock to areas where food is plentiful. Such areas include: rubbish (garbage) facilities; open sewage treatment works; recently ploughed land; as well as their natural habitats.
Source: N/A
Noise abatement
Noise-abatement procedures
Define the operator's responsibilities regarding the establishment of noise-abatement procedures.
Source: Point CAT.OP.MPA.130 'Noise abatement procedures — aeroplanes' Point CAT.OP.MPA.131 'Noise abatement procedures — helicopters'
State the main purpose of noise-abatement departure procedure (NADP) 1 and NADP 2.
Source: ICAO Doc 8168 'Procedures for Air Navigation Services — Aircraft Operations' (PANS-OPS), Volume 1, Part I, Section 7, Appendix to Chapter 3, 1.1
State that the PIC/commander has the authority to decide not to execute an NADP if conditions preclude the safe execution of the procedure.
Source: ICAO Doc 8168 'Procedures for Air Navigation Services — Aircraft Operations' (PANS-OPS), Volume 1, Part I, Section 7, Chapter 3, 3.2.1 General
Influence of the flight procedure (departure, cruise, approach)
List the main parameters for NADP 1 and NADP 2 (i.e. speeds, heights and configuration).
Source: ICAO Doc 8168 'Procedures for Air Navigation Services - Aircraft Operations' (PANS-OPS), Volume 1, Part I, Section 7, Chapter 3, 3.3 & Appendix to Chapter 3
State that a runway lead-in lighting system should be provided where it is desired to provide visual guidance along a specific approach path for noise-abatement purposes.
Source: ICAO Annex 14, Volume 1, 5.3.7.1/Volume 2, 5.3.4.1
State that detailed information about noise-abatement procedures is to be found in Part 'Aerodromes' (AD), Sections 2 and 3 of the AIP.
Source: ICAO Annex 15, Appendix 1
Influence by the pilot (power setting, low drag)
List the adverse operating conditions under which noise-abatement procedures in the form of reduced-power take-off should not be required.

Source: ICAO Doc 8168 'Procedures for Air Navigation Services - Aircraft Operations' (PANS-OPS), Volume 1, Part I, Section 3, Chapter 1, 1.2.3 Reduced power take-off

List the adverse operating conditions under which noise-abatement procedures during approach should not be required.

Source: ICAO Doc 8168 'Procedures for Air Navigation Services - Aircraft Operations' (PANS-OPS), Volume 1, Part I, Section 7, Chapter 2, 2.1 Noise preferential runways

State the rule regarding the use of reverse thrust on landing.

Source: ICAO Doc 8168 'Procedures for Air Navigation Services - Aircraft Operations' (PANS-OPS), Volume 1, Part I, Section 7, Chapter 3, 3.5 Aeroplane operating procedures - landing

Fire and smoke

Carburettor fire

Explain that the actions to be taken in the event of a carburettor fire may be type-specific and should be known by the pilot.

Engine fire

Explain that the actions to be taken in the event of an engine fire may be type-specific and should be known by the pilot.

Fire in the cabin, in the flight crew compartment and in the cargo compartment

Identify the different types of extinguishants used in handheld fire extinguishers and the type of fire for which each one may be used.

Describe the precautions to be considered when applying fire extinguishants.

Identify the appropriate handheld fire extinguishers to be used in the flight crew compartment, the passenger cabin and lavatories, and in the cargo compartments.

Smoke in the flight crew compartment and in the cabin

Explain which actions should be taken in the event of smoke in the flight crew compartment or in the cabin, why these actions may be type-specific, and why they should be known by the pilot.

Actions in case of overheated brakes

Describe the problems and safety precautions in the event that brakes overheat after a heavy-weight landing or a rejected take-off.

Explain the difference in the way steel and carbon brakes react to energy absorption and the operational consequences.

Decompression of pressurised cabin

Slow decompression

Explain what can cause, and how to detect, a slow decompression or an automatic pressurisation system failure.

Describe the actions required following a slow decompression.

Rapid and explosive decompression

Explain what can cause, and how to detect, a rapid or an explosive decompression.

Dangers and action to be taken

Describe the actions required following a rapid or explosive decompression.

Describe the effects on aircraft occupants of a slow decompression and of a rapid or explosive decompression.

Wind shear and microburst

Effects and recognition during departure and approach

Explain how to identify low-level wind shear.

Source: ICAO Circular 186 'Wind Shear'

Actions to avoid and actions to take when encountering wind shear

Describe the effects of wind shear and the actions required when wind shear is encountered at take-off and approach.

Source: ICAO Circular 186 'Wind Shear'

Describe the precautions to be taken when wind shear is suspected at take-off and approach.

Source: ICAO Circular 186 'Wind Shear'

Describe the effects of wind shear and the actions required following entry into a strong downdraft wind shear.

Source: ICAO Circular 186 'Wind Shear'

Describe a microburst and its effects.

Source: ICAO Circular 186 'Wind Shear'

Wake turbulence

Cause

Describe the term 'wake turbulence'.

Source: ICAO Doc 9426 'Air Traffic Services Planning Manual', Part II

Describe tip vortex circulation.

Source: ICAO Doc 9426 'Air Traffic Services Planning Manual', Part II

State when vortex generation begins and ends.
Source: ICAO Doc 9426 'Air Traffic Services Planning Manual', Part II
Describe vortex circulation on the ground with and without crosswind.
Source: ICAO Doc 9426 'Air Traffic Services Planning Manual', Part II
List of relevant parameters
List the three main factors which, when combined, give the strongest vortices (heavy, clean, slow).
Source: ICAO Doc 9426 'Air Traffic Services Planning Manual', Part II
Describe the wind conditions which are worst for wake turbulence near the ground.
Source: ICAO Doc 9426 'Air Traffic Services Planning Manual', Part II
Actions to be taken when crossing traffic, during take-off and landing
Describe the actions to be taken to avoid wake turbulence, specifically separations.
Source: ICAO Doc 4444 'Procedures for Air Navigation Services — Air Traffic Management' (PANS-ATM), 5.8 Timebased wake turbulence longitudinal separation minima
Security (unlawful events)
ICAO Annex 17 and Regulation (EC) No 300/2008
Define the following terms: 'aircraft security check', 'screening', 'security', 'security-restricted area', 'unidentified baggage'.
Source: ICAO Annex 17, Chapter 1 Definitions
State the objectives of security.
Source: ICAO Annex 17, 2.1 Objectives
Use of Secondary Surveillance Radar (SSR)
Describe the commander's responsibilities concerning notifying the appropriate ATS unit.
Source: ICAO Annex 17, Attachment to Annex 17
Describe the commander's responsibilities concerning operation of SSR.
Source: ICAO Annex 17, Attachment to Annex 17
Describe the commander's responsibilities concerning departing from assigned track or cruising level.
Source: ICAO Annex 17, Attachment to Annex 17
Describe the commander's responsibilities concerning the action required or being requested by an ATS unit to confirm SSR code and ATS interpretation response.
Source: ICAO Annex 17, Attachment to Annex 17
Security (Regulation (EC) No 300/2008 and ICAO Annex 17)
Describe the relationship between Regulation (EC)
No 300/2008 and ICAO Annex 17.
Source: Regulation (EC) No 300/2008, Articles 1 and 2
Explain the requirements regarding training programmes.
Source: Regulation (EC) No 300/2008, Annex: 10 'In-flight security measures' and 11 'Staff recruitment and training'; ICAO Annex 17, 13.4 Training programmes
State the requirements regarding reporting acts of unlawful interference.
Source: ICAO Annex 17, 13.5 Reporting acts of unlawful interference
State the requirements regarding aircraft search procedures.
Source: ICAO Annex 17: 4.3 Measures relating to aircraft;
5.1 Prevention; 13.3 Aeroplane search procedure checklist
Emergency and precautionary landing, and ditching
Descriptions
Describe the meaning of: 'ditching', 'precautionary landing',
and 'emergency landing'.
Describe a ditching procedure.
Describe a precautionary landing procedure.
Describe an emergency landing procedure.
Explain the factors to be considered when deciding to conduct a precautionary/emergency landing or ditching.
Cause
List some circumstances that may require a ditching, a precautionary landing or an emergency landing.
Passenger information
Describe the briefing to be given to passengers before conducting a precautionary/emergency landing or ditching (including evacuation).
Source: AMC1 CAT.OP.MPA.170 'Passenger briefing'
Action after a precautionary/emergency landing or ditching
Describe the actions and responsibilities of crew members after landing.
Evacuation
Explain why the aircraft must be stopped and the engine(s) shut down before launching an emergency evacuation.

Explain the CS-25 requirements regarding evacuation procedures.
Source: CS 25.803 and Appendix J

Fuel jettisoning

Safety aspects

Explain why an aircraft may need to jettison fuel so as to reduce its landing mass in order to make a safe landing.
Source: ICAO Doc 4444 'Procedures for Air Navigation Services — Air Traffic Management' (PANS-ATM), 15.5.3 Fuel dumping

Explain that when an aircraft that operates within controlled
airspace needs to jettison fuel, the flight crew shall coordinate with ATC the following:
— route to be flown which, if possible, should be clear of
cities and towns, preferably over water and away from
areas where thunderstorms have been reported or are
expected;
— the flight level to be used, which should be not less than 1 800 m (6 000 ft); and
— the duration of fuel jettisoning.
Source: ICAO Doc 4444 'Procedures for Air Navigation Services — Air Traffic Management' (PANS-ATM), 15.5.3 Fuel dumping

Explain how flaps and slats may adversely affect fuel jettisoning.
Source: CS 25.1001 Fuel jettisoning system

Requirements

Explain why a fuel-jettisoning system must be capable of jettisoning enough fuel within 15 minutes.
Source: CS 25.1001 Fuel jettisoning system

Transport of dangerous goods by air

ICAO Annex 18 (4th Edition, July 2011)

Define the following terms:'dangerous goods', 'dangerous goods accident', 'dangerous goods incident', 'exemption', 'incompatible', 'packaging', 'UN number'.
Source: ICAO Annex 18, Chapter 1 Definitions

Explain that detailed provisions for the transport of dangerous goods by air are contained in the Technical Instructions for the Safe Transport of Dangerous Goods by Air.
Source:ICAO Doc 9284 'Technical Instructions For The Safe Transport of Dangerous Goods by Air'; ICAO Annex 18, Chapter 2, 2.2.1

State that in the event of an in-flight emergency, the pilot-incommand must inform the ATC of the transport of dangerous goods by air.
Source: ICAO Annex 18, Chapter 9, 9.5

Technical Instructions for the Safe Transport of Dangerous Goods by Air (ICAO Doc 9284)

Explain the principle of dangerous goods compatibility and segregation.
Source: ICAO Doc 9284 'Technical Instructions For The Safe Transport of Dangerous Goods by Air'

Explain the special requirements for the loading of radioactive materials.
Source: ICAO Doc 9284 'Technical Instructions For The Safe Transport of Dangerous Goods by Air'

Explain the use of the dangerous goods list.
Source: ICAO Doc 9284 'Technical Instructions For The Safe Transport of Dangerous Goods by Air'

Identify the labels.
Source: ICAO Doc 9284 'Technical Instructions For The Safe Transport of Dangerous Goods by Air'

Regulation (EU) No 965/2012 — Annex IV (Part-CAT) and Annex V (Part-SPA)

Explain the terminology relevant to dangerous goods.
Source: Point SPA.DG.100 'Transport of dangerous goods'; Point SPA.DG.105 'Approval to transport dangerous goods'; Point SPA.DG.110 'Dangerous goods information and documentation'

Explain the scope of that Regulation.
Source: Point CAT.GEN.MPA.200 'Transport of dangerous goods'

Explain why the transport of dangerous goods by air is subject to operator approval.
Source: Point SPA.DG.100 'Transport of dangerous goods'; AMC1 ARO.OPS.200 'Specific approval procedure'

Explain the limitations on the transport of dangerous goods by air.
Source: Point SPA.DG.100 'Transport of dangerous goods'; Point SPA.DG.105 'Approval to transport dangerous goods'; Point SPA.DG.110 'Dangerous goods information and documentation'

Explain the requirements for the acceptance of dangerous goods.
Source:Point SPA.DG.110 'Dangerous goods information and documentation'; AMC1 SPA.DG.110(b) 'Dangerous goods information and documentation'

Explain the requirements regarding inspection for damage, leakage or contamination.
Source: Point SPA.DG.105 'Approval to transport dangerous goods'; AMC1 SPA.DG.110(b) 'Dangerous goods information and documentation': (a)(1)
Explain the requirement for the provision of information to flight crew.
Source: Point SPA.DG.110 'Dangerous goods information and documentation'; AMC1 SPA.DG.110(a);(b) 'Dangerous goods information and documentation'
Explain the requirements for dangerous goods incident and accident reports.
Source: Point CAT.GEN.MPA.200 'Transport of dangerous goods'
State that some articles and substances, which would otherwise be classed as dangerous goods, can be exempted if they are part of the aircraft equipment, or required for use during aeromedical flights.
Source: Point CAT.GEN.MPA.200 'Transport of dangerous goods'; ICAO Doc 9284 'Technical Instructions For The Safe Transport of Dangerous Goods by Air', 2.2 Exceptions for dangerous goods of the operator
Explain why some articles and substances may be forbidden for transport by air.
Source: Point CAT.GEN.MPA.200 'Transport of dangerous goods'; ICAO Doc 9284 'Technical Instructions For The Safe Transport of Dangerous Goods by Air', 2.1 Dangerous goods forbidden for transport by air under any circumstance
Explain why packing must comply with the specifications of the Technical Instructions.
Source: ICAO Doc 9284 'Technical Instructions For The Safe Transport of Dangerous Goods by Air', Introductory chapter, 2.4 (for packing purposes, etc.)
Explain the need for an inspection prior to loading dangerous goods on an aircraft.
Source: Point CAT.GEN.MPA.200 'Transport of dangerous goods'; AMC1 SPA.DG.110(b) 'Dangerous goods information and documentation'
Explain why some dangerous goods are designated for carriage only on cargo aircraft.
Source:ICAO Annex 18, 8.9 Loading on cargo aircraft; ICAO Doc 9284 'Technical Instructions For The Safe Transport of Dangerous Goods by Air', GENERAL PRINCIPLES
Explain how misdeclared or undeclared dangerous goods found in baggage are to be reported.
Source: Point CAT.GEN.MPA.200 and related AMCs/GM

Contaminated runways

Estimated surface friction, friction coefficient

Identify the difference between friction coefficient and estimated surface friction.
Source: ICAO Annex 15, Appendix 2
State that when estimated surface friction is 4 or 5, the expected braking action is good.
Source: ICAO Annex 15, Appendix 2

Hydroplaning principles and effects

Define the different types of hydroplaning.
Source: NASA TM-85652 - Tire friction performance
Compute the two dynamic hydroplaning speeds using the following formulas: — spin-down speed (rotating tire) (kt) = 9 square root
(pressure in PSI) — spin-up speed (non-rotating tire) (kt) = 7.7 square root (pressure in PSI).
Source: NASA TM-85652 — Tire friction performance
State that it is the spin-up speed rather than the spin-down speed which represents the actual tire situation for aircraft touchdown on flooded runways.
Source: NASA TM-85652 — Tire friction performance

SNOWTAM and contamination on the aerodrome

Interpret from a SNOWTAM the contamination and braking action on a runway, taxiways and apron.
Source: ICAO Annex 15, Appendix 2
Explain which hazards can be identified from the SNOWTAM/METAR and how to mitigate them.

SPECIALISED OPERATIONS (Regulation (EU) No 965/2012 on air operations, as amended)

Additional requirements for commercial specialised operations and CAT operations (Annex III (Part-ORO), Subpart FC, Section 3)

Explain the requirements related to flight crew recurrent training and checking and operator proficiency check.
Source: Point ORO.FC.330 'Recurrent training and checking - operator proficiency check'

General requirements (Annex VIII (Part-SPO), Subpart A)

Explain the task specialist's responsibilities.
Source: Point SPO.GEN.106 'Task specialists responsibilities'

081. PRINCIPLES OF FLIGHT — AEROPLANES

SUBSONIC AERODYNAMICSF4:F7
Basics, laws and definitions

Laws and definitions
List the international system of units of measurement (SI) for mass, acceleration, weight, velocity, energy, density, temperature, pressure, force, wing loading, and power.
Define 'mass', 'force', 'acceleration', and 'weight'.
State and interpret Newton's three laws of motion.
Explain air density.
List the atmospheric properties that effect air density.
Explain how temperature and pressure changes affect air density.
Define 'static pressure'.
Define 'dynamic pressure'.
State the formula for 'dynamic pressure'.
Describe dynamic pressure in terms of an indication of the energy in the system, and how it is related to indicated airspeed (IAS) and air density for a given altitude and speed.
State Bernoulli's equation for incompressible flow.
Define 'total pressure' and explain that the total pressure differs in different systems.
Apply Bernoulli's equation to flow through a venturi stream tube for incompressible flow.
Describe how IAS is acquired from the pitot static system.
Describe the relationship between density, temperature, and pressure for air.
Explain the equation of continuity and its application to the flow through a stream tube.
Define 'IAS', 'CAS', 'EAS', and 'TAS'.
Basics of airflow
Describe steady and unsteady airflow.
Explain the concept of a streamline and a stream tube.
Describe and explain airflow through a stream tube.
Explain the difference between two- and three-dimensional airflow.
Aerodynamic forces on aerofoils
Describe the originating point and direction of the resultant force caused by the pressure distribution around an aerofoil.
Resolve the resultant force into the components 'lift' and 'drag'.
Describe the direction of lift and drag.
Define the 'aerodynamic moment'.
List the factors that affect the aerodynamic moment.
Describe the aerodynamic moment for a symmetrical aerofoil.
Describe the aerodynamic moment for a positively and negatively cambered aerofoil.
Define 'angle of attack' (α).
Shape of an aerofoil section
Describe the following parameter of an aerofoil section: leading edge.
Describe the following parameter of an aerofoil section: trailing edge.
Describe the following parameter of an aerofoil section: chord line.
Describe the following parameter of an aerofoil section: thickness-to-chord ratio or relative thickness.
Describe the following parameter of an aerofoil section: location of maximum thickness.
Describe the following parameter of an aerofoil section: camber line.
Describe the following parameter of an aerofoil section: camber.
Describe the following parameter of an aerofoil section: nose radius.
Describe a symmetrical and an asymmetrical aerofoil section.
Wing shape
Describe the following parameter of a wing: span.
Describe the following parameter of a wing: tip and root chord.
Describe the following parameter of a wing: taper ratio.
Describe the following parameter of a wing: wing area.
Describe the following parameter of a wing: wing planform.
Describe the following parameter of a wing: mean geometric chord.
Describe the following parameter of a wing: mean aerodynamic chord (MAC).
Describe the following parameter of a wing: aspect ratio.
Describe the following parameter of a wing: dihedral angle.
Describe the following parameter of a wing: sweep angle.
Describe the following parameter of a wing: wing twist, geometric and aerodynamic.
Describe the following parameter of a wing: angle of incidence.
Remark: In certain textbooks, angle of incidence is used as angle of attack (α). For Part-FCL theoretical knowledge

examination purposes, this use is discontinued, and the angle of incidence is defined as the angle between the aeroplane longitudinal axis and the wing-root chord line.

Two-dimensional airflow around an aerofoil

Streamline pattern

Describe the streamline pattern around an aerofoil.

Describe converging and diverging streamlines, and their effect on static pressure and velocity.

Describe upwash and downwash.

Stagnation point

Describe the stagnation point.

Describe the movement of the stagnation point as the α changes.

Pressure distribution

Describe pressure distribution and local speeds around an aerofoil including effects of camber and α.

Centre of pressure (CP) and aerodynamic centre (AC)

Explain CP and AC.

Drag and wake

List two physical phenomena that cause drag.

Describe skin friction drag.

Describe form (pressure) drag.

Explain why drag and wake cause loss of energy (momentum).

Influence of angle of attack (α)

Explain the influence of α on lift.

The lift coefficient (C_L) - angle of attack (α) graph

Describe the C_L-α graph.

Explain the significant points: point where the curve crosses the horizontal axis (zero lift); point where the curve crosses the vertical axis (α= 0); point where the curve reaches its maximum (C_{LMAX}).

Coefficients

General use of coefficients

Explain why coefficients are used in general.

The lift coefficient (CL)

Explain the lift formula, the factors that affect lift, and perform simple calculations.

Describe the effect of camber on the C_L-α graph (symmetrical and positively/negatively cambered aerofoils).

Describe the typical difference in the CL-α graph for fast and slow aerofoil design.

Define 'C_{LMAX}' (maximum lift coefficient) and 'αC_{RIT}' (stalling α) on the graph.

Describe C_L and explain the variables that affect it in low subsonic flight.

Drag

Describe the two-dimensional drag formula.

Discuss the effect of the shape of a body, cross-sectional area, and surface roughness on the drag coefficient.

Three-dimensional airflow around an aeroplane

Angle of attack (α)

Define 'angle of attack' (α).

Remark: For theoretical knowledge examination purposes, the angle-of-attack definition requires a reference line. This reference line for 3D has been chosen to be the longitudinal axis and for 2D the chord line.

Explain the difference between the α and the attitude of an aeroplane.

Streamline pattern

Describe the general streamline pattern around the wing, tail section, and fuselage.

Explain and describe the causes of spanwise flow over top and bottom surfaces.

Describe wing tip vortices and their contribution to downwash behind the wing.

Explain why wing tip vortices vary with α.

Describe spanwise lift distribution including the effect of wing planform.

Describe the causes, distribution and duration of the wake turbulence behind an aeroplane.

Describe the influence of flap deflection on the wing tip vortex.

Describe the parameters that influence wake turbulence.

Induced drag

Explain the factors that cause induced drag.

Describe the approximate formula for the induced drag coefficient (including variables but excluding constants).

Describe the relationship between induced drag and total drag in straight and level flight with variable speed.

Describe the effect of mass on induced drag at a given IAS.

Describe the means to reduce induced drag: aspect ratio; winglets; tip tanks; wing twist; camber change.

Describe the influence of lift distribution on induced drag.

Describe the influence of downwash on the effective airflow.

Explain induced and effective local α.
Explain the influence of the induced α on the direction of the lift vector.
Explain the relationship between induced drag and: speed; aspect ratio; wing planform; bank angle in a horizontal coordinated turn.
Explain the induced drag coefficient and its relationship with the lift coefficient and aspect ratio.
Explain the influence of induced drag on: the C_L-α graph, and show the effect on the graph when comparing high- and low-aspect ratio wings; the C_L-C_D (aeroplane polar), and show the effect on the graph when comparing high- and low-aspect ratio wings; the parabolic aeroplane polar in a graph and as a formula [$C_D = C_{PD} + kC_L^2$], where C_D = coefficient of drag and C_{PD} = coefficient of parasite drag.
Describe the C_L- C_D graph (polar).
Indicate minimum drag on the graph.
Explain why the C_L-C_D ratio is important as a measure of performance.

Total drag

Total drag in relation to parasite drag and induced drag

State that total drag consists of parasite drag and induced drag.

Parasite drag

Describe the types of drag that are included in parasite drag.
Describe form (pressure) drag and the factors which affect its magnitude.
Describe interference drag and the factors which affect its magnitude.
Describe friction drag and the factors which affect its magnitude.

Parasite drag and speed

Describe the relationship between parasite drag and speed.

Induced drag and speed (Refer to 081 01 04 03)

Total drag

Explain the total drag-speed graph and the constituent drag components.
Indicate the speed for minimum drag.

Variables affecting the total drag-speed graph

Describe the effect of aeroplane gross mass on the graph.
Describe the effect of pressure altitude on: drag-IAS graph; drag-TAS graph.
Describe speed stability from the graph.
Describe non-stable, neutral, and stable IAS regions.
Explain what happens to the IAS and drag in the non-stable region if speed suddenly decreases and why this could occur.

Ground effect

Influence of ground effect

Explain the influence of ground effect on wing tip vortices, downwash, airflow pattern, lift, and drag.
Describe the influence of ground effect on induced α and the coefficient of induced drag (C_{Di}).
Explain the effects of entering and leaving ground effect.

Effect on stalling angle of attack (α_{CRIT})

Describe the influence of ground effect on α_{CRIT}.

Effect on lift coefficient (C_L)

Describe the influence of ground effect on the effective α and C_L.

Effect on take-off and landing characteristics of an aeroplane

Describe the influence of ground effect on take-off and landing characteristics and performance of an aeroplane.
Describe the difference in take-off and landing characteristics of high- and low-wing aeroplanes.

The relationship between lift coefficient and speed in steady, straight, and level flight

Represented by an equation

Explain the effect on C_L during speed increase/decrease in steady, straight, and level flight, and perform simple calculations.

Represented by a graph

Explain, by using a graph, the effect on speed of C_L changes at a given weight.

CLMAX augmentation

Trailing-edge flaps and the reasons for their use in take-off and landing

From the given relevant diagrams, describe or identify the following types of trailing-edge flaps: split flaps; plain flaps; slotted flaps; Fowler flaps.
Describe how the wing's effective camber increases the C_L and C_D, and the reasons why this can be beneficial.
Describe their effect on: the location of CP; pitching moments (due to wing CP movement); stall speed.
Compare their influence on the C_L-α graph: indicate the variation in C_L at any given α; indicate their effect on C_{LMAX}; indicate their effect on critical α; indicate their effect on the α at a given C_L.
Compare their influence on the C_L-C_D graph: indicate how the $(C_L/C_D)_{MAX}$ differs from that of a clean wing.

Explain the influence of trailing-edge flap deflection on the glide angle.
Describe flap asymmetry: explain the effect on aeroplane controllability.
Describe trailing-edge flap effect on take-off and landing: explain the advantages of lower-nose attitudes; explain why take-off and landing speeds/distances are reduced.
Explain the effects of flap-setting errors, such as mis-selection and premature/late extension or retraction of flaps, on: take-off and landing distance and speeds; climb and descent performance; stall buffet margins.

Leading-edge devices and the reasons for their use in take-off and landing

From the given relevant diagrams, describe or identify the different types of leading-edge high-lift devices: Krueger flaps; variable camber flaps; slats.
Describe the function of the slot.
Describe how the wing's effective camber increases with a leading-edge flap.
Explain the effect of leading-edge flaps on the stall speed, also in comparison with trailing-edge flaps.
Compare their influence on the C_L-α graph, compared with trailing-edge flaps and a clean wing: indicate the effect of leading-edge devices on C_{LMAX}; explain how the C_L curve differs from that of a clean wing; indicate the effect of leading-edge devices on α_{CRIT}.
Compare their influence on the C_L-C_D graph.
Describe slat asymmetry: describe the effect on aeroplane controllability.
Explain the reasons for using leading-edge high-lift devices on take-off and landing: explain the disadvantage of increased nose-up attitudes; explain why take-off and landing speeds/distances are reduced.

Vortex generators

Explain the purpose of vortex generators.
Describe the basic operating principle of vortex generators.
State their advantages and disadvantages.

Means to reduce the C_L-C_D ratio

Spoilers and the reasons for their use in the different phases of flight

Describe the aerodynamic functioning of spoilers: roll spoilers; flight spoilers (speed brakes); ground spoilers (lift dumpers).
Describe the effect of spoilers on the C_L-α graph and stall speed.
Describe the influence of spoilers on the C_L-C_D graph and lift-drag ratio.

Speed brakes and the reasons for their use in the different phases of flight

Describe speed brakes and the reasons for using them in the different phases of flight.
State their influence on the C_L- C_D graph and lift-drag ratio.
Explain how speed brakes increase parasite drag.
Describe how speed brakes affect the minimum drag speed.
Describe their effect on rate and angle of descent.

Aerodynamic degradation

Ice and other contaminants

Describe the locations on an aeroplane where ice build-up will occur during flight.
Explain the aerodynamic effects of ice and other contaminants on: lift (maximum CL); drag; stall speed; α_{CRIT}; stability and controllability.
Explain the aerodynamic effects of icing during take-off.

Deformation and modification of airframe, ageing aeroplanes

Describe the effect of airframe deformation and modification of an ageing aeroplane on aeroplane performance.
Explain the effect on boundary layer condition of an ageing aeroplane.

HIGH-SPEED AERODYNAMICS

Speeds

Speed of sound

Define 'speed of sound'.
Explain the variation of the speed of sound with altitude.
Explain the influence of temperature on the speed of sound.

Mach number

Define 'Mach number' as a function of TAS and speed of sound.

Influence of temperature and altitude on Mach number

Explain the absence of change of Mach number with varying temperature at constant flight level and calibrated airspeed.
Explain the relationship between Mach number, TAS and IAS during climb and descent at constant Mach number or IAS, and explain variation of lift coefficient, α, pitch and flight-path angle.
Explain: risk of exceeding the maximum operation speed (VMO) when descending at constant Mach number; risk of exceeding the maximum operating Mach number (MMO) when climbing at constant IAS; risk of a low-speed stall at high altitude when climbing at a too low Mach number.

Compressibility
State that compressibility means that density can change along a streamline, and that this occurs in the high subsonic (from Mach 0.4), transonic, and supersonic flow.
State that compressibility negatively affects the pressure gradient, leading to an overall reduction of the C_L.
State that Mach number is a measure of compressibility.
Describe that compressibility increases low-speed stall speed and decreases the α_{CRIT}.
Subdivision of aerodynamic flow
List the subdivision of aerodynamic flow: subsonic flow below compressibility; subsonic flow above compressibility; transonic flow; supersonic flow.
Describe the characteristics of the flow regimes listed above.
Explain why some transport aeroplanes cruise at Mach numbers above the critical Mach number (M_{CRIT}).
Shock waves
Definition of shock wave
Define a 'shock wave'.
Normal shock waves
Describe a normal shock wave with respect to changes in: static temperature; static and total pressure; velocity; local speed of sound; Mach number; density.
Describe a normal shock wave with respect to orientation relative to the wing surface.
Explain the influence of increasing Mach number on a normal shock wave, at positive lift, with respect to: strength; position relative to the wing; second shock wave at the lower surface.
Explain the influence of α on shock-wave intensity and shock-wave location at constant Mach number.
Effects of exceeding the critical Mach number (MCRIT)
Critical Mach number (MCRIT)
Define 'MCRIT'.
Explain how a change in α, aeroplane weight, manoeuvres, and centre-of-gravity (CG) position influences M_{CRIT}.
Effect on lift
Describe the behaviour of C_L versus Mach number at constant α.
Explain the consequences of exceeding M_{CRIT} with respect to C_L and C_{LMAX}.
Explain the change in stall indicated airspeed (IAS) with altitude.
Discuss the effect on α_{CRIT}.
Explain the advantages of exceeding M_{CRIT} in aeroplanes with supercritical aerofoils with respect to: speed versus drag ratio; specific range; optimum altitude.
Effect on drag
Describe wave drag.
Describe the behaviour of C_D versus Mach number at constant α.
Explain effect of Mach number on the C_L-C_D graph.
Describe the effects and hazards of exceeding $M_{DRAG\ DIVERGENCE}$, namely: drag rise; instability; Mach tuck; shock stall.
State the relation between M_{CRIT} and $M_{DRAG\ DIVERGENCE}$.
Effect on pitching moment
Discuss the effect of Mach number on the CP location.
Describe the overall change in pitching moment above M_{CRIT} and explain the 'tuck under' or 'Mach tuck' effect.
State the requirement for a Mach trim system to compensate for the effect of the CP movement and 'tuck under' effect.
Discuss the aerodynamic functioning of the Mach trim system.
Discuss the corrective measures if the Mach trim fails.
Effect on control effectiveness
Discuss the effects on the effectiveness of control surfaces.
Means to influence critical Mach number (MCRIT)
Wing sweep
Explain the influence of the angle of sweep on: M_{CRIT}; effective thickness/chord change or velocity component perpendicular to the quarter chord line.
Describe the influence of the angle of sweepback at subsonic speed on: C_{LMAX}; efficiency of and requirement for high-lift devices; pitch-up stall behaviour.
Discuss the effect of wing sweepback on drag.
Aerofoil shape
Explain the use of thin aerofoils with reduced camber.
Explain the main purpose of supercritical aerofoils.
Explain the advantages and disadvantages of supercritical aerofoils for wing design.
Vortex generators

Explain the use of vortex generators as a means to avoid or restrict flow separation caused by the presence of a normal shock wave.

Stall, Mach tuck, and upset prevention and recovery

The stall

Flow separation at increasing α

Define the 'boundary layer'.
Describe the thickness of a typical laminar and turbulent boundary layer.
Describe the properties, advantages and disadvantages of the laminar boundary layer.
Describe the properties, advantages and disadvantages of the turbulent boundary layer.
Define the 'transition point'.
Explain why the laminar boundary layer separates easier than the turbulent boundary layer does.
Describe why the airflow over the aft part of a wing slows down as the α increases.
Define the 'separation point' and describe its location as a function of α.
Define α_{CRIT}.
Describe in straight and level flight the influence of increasing the α and the phenomenon that may occure regarding: the forward stagnation point; the pressure distribution; the CP location (straight and swept-back wing); C_L; C_D and D (drag); the pitching moment (straight and swept-back wing); buffet onset; deterrent buffet for a clean wing at high Mach number; lack of pitch authority; uncommanded pitch down; uncommanded roll.
Explain what causes the possible natural buffet on the aeroplane in a pre-stall condition.
Describe the effectiveness of the flight controls in a pre-stall condition.
Describe and explain the normal post-stall behaviour of a straight-wing aeroplane.
Describe the effect and dangers of using the controls close to the stall.
Describe the deterrent buffet.
Explain the occurrence of the deterrent buffet and why this phenomenon is considered to be a stall limit.

The stall speed

Explain V_{S0}, V_{S1}, V_{SR}, and V_{S1G}.
Solve V_{S1G} from the lift formula given varying CL.
Describe and explain the influence of the following parameters on stall speed: CG; thrust component; slipstream; wing loading; mass; wing contamination; angle of sweep; altitude (for compressibility effects, see 081 02 03 02).
Define the 'load factor n'.
Explain why the load factor increases in a turn.
Explain why the load factor increases in a pull-up and decreases in a push-over manoeuvre.
Describe and explain the influence of the 'load factor n' on stall speed.
Explain the expression 'accelerated stall'.
Remark: Sometimes, accelerated stall is also erroneously referred to as high-speed stall. This latter expression will not be used for Subject 081.
Calculate the change of stall speed as a function of the load factor.
Calculate the increase of stall speed in a horizontal co-ordinated turn as a function of bank angle.
Calculate the change of stall speed as a function of the gross mass.

The initial stall in spanwise direction

Explain the initial stall sequence on the following planforms: elliptical; rectangular; moderate and high taper; sweepback or delta.
Explain the purpose of aerodynamic and geometric twist (washout).
Explain the influence of fences, vortilons, saw teeth, vortex generators, and strakes on engine nacelles.

Stall warning

Explain why stall warning is necessary.
Explain when aerodynamic and artificial stall warnings are used.
Explain why CS-23 and CS-25 require a margin to stall speed for take-off and landing speeds.
Describe: buffet; stall strip; flapper switch (leading-edge stall-warning vane); angle-of-attack vane; angle-of-attack probe; stick shaker.
Describe the recovery after: stall warning; stall; stick-pusher actuation.

Special phenomena of stall

Explain the difference between power-off and power-on stalls and recovery.
Describe the stall and recovery in a climbing and descending turn.
Describe the pitch-up effect on a swept wing aeroplane and also an aeroplane with a T-tail.
Describe super stall or deep stall.
Describe the philosophy behind the stick-pusher system.
Describe the factors that can lead to the absence of stall warning and explain the associated risks.
Describe the indications and explain the consequences of premature stabiliser stall due to ice contamination (negative tail stall).

Describe when to expect in-flight icing.
Explain how the effect is changed when retracting/extending lift-augmentation devices.
Describe how to recover from a stall after a configuration change caused by in-flight icing.
Explain the hazards associated with airframe contamination when parked and during ground operations in winter conditions, and the aerodynamic effects when attempting a take-off.
Explain de-icing/anti-icing holdover time and the likely hazards after it has expired.
Describe the aerodynamic effects of heavy tropical rain on stall speed and drag, and the appropriate mitigation in such conditions.

The spin

Explain how to avoid spins.
List the factors that cause a spin to develop.
Describe an 'incipient' and 'developed' spin, recognition and recovery.
Describe the differences in spin attitude with forward and aft CG.

Buffet onset boundary

Mach buffet

Explain shock-induced separation and describe its relationship with Mach buffet (high speed buffet) and Mach tuck.

Buffet onset

Explain the concept of buffet margin, and describe the influence of the following parameters on the concept of buffet margin: α; Mach number; pressure altitude; mass; load factor; angle of bank; CG location.
Explain how the buffet onset boundary chart can be used to determine: manoeuvrability; buffet margin.
Describe the consequences of exceeding M_{MO}: light buffet, buffet onset.
Explain 'aerodynamic ceiling' and 'coffin corner'.
Explain the concept of the '1.3g' buffet margin altitude.
Find (using an example graph): buffet free range; aerodynamic ceiling at a given mass; load factor and bank angle at which buffet occurs at a given mass, Mach number, and pressure altitude.
Explain why descent increases the buffet free range.

Situations in which buffet or stall could occur

Explain why buffet or stall occurs

Explain why buffet or stall could occur in the following pilot-induced situations, and the methods to mitigate them: inappropriate take-off configuration, detailing the consequences of errors associated with leading-edge devices; steep turns; go-around using take-off/go-around (TOGA) setting (underslung engines).
Explain why buffet or stall could occur in the following environmental conditions at low altitude, and how to mitigate them: thunderstorms; wind shear and microburst; turbulence; wake turbulence; icing conditions.
Explain why buffet or stall could occur in the following environmental conditions at high altitude, and how to mitigate them: thunderstorms in the intertropical convergence zone (ITCZ); jet streams; clear-air turbulence.
Explain why buffet or stall could occur in the following situations, and how to mitigate them: inappropriate autopilot climb mode; loss of, or unreliable, airspeed indication.

Recognition of stalled condition

Recognition and explanation of stalled condition

Explain why a stalled condition can occur at any airspeed, or attitude or altitude.
Explain that a stall may be recognised by continuous stall-warning activation accompanied by at least one of the following: buffet, that can be heavy; lack of pitch authority; uncommanded pitch down and uncommanded roll; inability to arrest the descent rate.
Explain that 'stall warning' means a natural or synthetic indication provided when approaching the stall that may include one or more of the following indications: aerodynamic buffeting; reduced roll stability and aileron effectiveness; visual or aural clues and warnings; reduced elevator (pitch) authority; inability to maintain altitude or arrest a rate of descent; stick-shaker activation.

STABILITY

Static and dynamic stability

Basics and definitions

Define 'static stability': describe/identify a statically stable, neutral, and unstable condition (positive, neutral, and negative static stability); and explain why aeroplanes are statically stable.
Explain manoeuvrability.
Explain the relationship between static stability and manoeuvrability.
Define 'dynamic stability': describe/identify a dynamically stable, neutral, and unstable motion (positive, neutral, and negative dynamic stability); describe/identify periodic and aperiodic motion.

Precondition for static stability

Explain an equilibrium of forces and moments as the initial condition for static stability.

Sum of forces

Identify the forces considered in the equilibrium of forces.

Sum of moments
Identify the moments about all three axes considered in the equilibrium of moments.
Discuss the effect of sum of moments not being zero.
Static and dynamic longitudinal stability
Methods for achieving balance
Explain the stabiliser as the means to satisfy the condition of nullifying the total sum of the moments about the lateral axis.
Explain the influence of the location of the wing CP relative to the CG on the magnitude and direction of the balancing force on the stabiliser.
Explain the influence of the indicated airspeed on the magnitude and direction of the balancing force on stabiliser.
Explain the use of the elevator deflection or stabiliser angle for the generation of the balancing force and its direction.
Explain the elevator deflection required to balance thrust changes as a function of engine position.
Static longitudinal stability
Discuss the effect of the CG location on pitch manoeuvrability and longitudinal stability.
Neutral point
Define 'neutral point'.
Explain why the location of the neutral point is only dependent on the aerodynamic design of the aeroplane.
Factors affecting neutral point
Describe the location of the neutral point relative to the locations of the aerodynamic centre of the wing and tail.
Location of centre of gravity (CG)
Explain the influence of the CG location on the static longitudinal stability of the aeroplane.
Explain the CG forward and aft limits with respect to: longitudinal control forces; elevator effectiveness; stability.
Define 'static margin'.
The Cm-α graph
Describe the C_m-α graph with respect to the relationship between the slope of the graph and static stability.
Factors affecting the Cm-α graph
Explain:
the effect on the C_m-α graph of a shift of CG in the forward and aft direction;
the effect on the C_m-α graph when the elevator is moved up or down;
the effect on the C_m-α graph when the trim is moved;
the effect of the wing contribution;
the tail contribution.
The stick force versus speed graph (IAS)
Explain how a pilot perceives stable static longitudinal stick force stability regarding changes in: speed; altitude; mass distribution (CG location).
The manoeuvring stability/stick force per g
Define the 'stick force per g', and describe that the stick force increases linearly with increase in g.
Explain why: the stick force per g has a prescribed minimum and maximum value; the stick force per g decreases with pressure altitude.
Factors affecting the manoeuvring stability/stick force per g
Explain the influence on stick force per g of: CG location; trim setting.
Dynamic longitudinal stability
Describe the phugoid and short-period motion in terms of period, damping, variations (if applicable) in speed, altitude, and α.
Explain why the short-period motion is more hazardous than the phugoid.
Describe 'pilot-induced oscillations'.
Explain the effect of high altitude on dynamic stability.
Describe the influence of the CG location on the dynamic longitudinal stability of the aeroplane.
Static directional stability
Definition and effects of static directional stability
Define 'static directional stability'.
Explain the effects of static directional stability being too weak or too strong.
Sideslip angle
Define 'sideslip angle'.
Identify β as the symbol used for the sideslip angle.
Yaw-moment coefficient Cn
Define the 'yawing-moment coefficient Cn'.
Define the relationship between Cn and β for an aeroplane with static directional stability.
Cn-β graph

Explain why:
Cn depends on β;
Cn equals zero for that β that provides static equilibrium about the aeroplane's normal axis;
if no asymmetric engine thrust, flight control or loading condition prevails, the equilibrium β equals zero.
Identify how the slope of the Cn-β graph is a measure for static directional stability.
Identify how the slope of the Cn-β graph is affected by altitude.
Factors affecting static directional stability
Describe how the following aeroplane components contribute to static directional stability:
wing;
fin;
dorsal fin;
ventral fin;
angle of sweep of the wing;
angle of sweep of the fin;
fuselage at high α;
strakes.
Explain the reduction in static directional stability when the CG moves aft.
Static lateral stability
Definition and effects of static lateral stability
Define 'static lateral stability'.
Explain the effects of static lateral stability being too weak or too strong.
Bank angle Ø
Define 'bank angle Ø'.
The roll-moment coefficient C_l
Define the 'roll-moment coefficient C_l'.
Contribution of sideslip angle (β)
Explain how without coordination the bank angle (Ø) creates sideslip angle (β).
The Cl-β graph
Describe the C_l-β graph.
Identify the slope of the C_l-β graph as a measure for static lateral stability.
Identify how the slope of the Cl-β graph is affected by altitude.
Factors affecting static lateral stability
Explain the contribution to the static lateral stability of:
dihedral, anhedral;
high wing, low wing;
sweep angle of the wing;
ventral fin;
vertical tail.
Dynamic lateral/directional stability
Tendency to spiral dive
Explain how lateral and directional stability are coupled.
Explain how high static directional stability and low static lateral stability may cause spiral divergence (unstable spiral dive), and under which conditions the spiral dive mode is neutral or stable.
Describe an unstable spiral dive mode with respect to deviations in speed, bank angle, nose low-pitch attitude, and decreasing altitude.
Dutch roll
Describe Dutch roll.
Explain: why Dutch roll occurs when the static lateral stability is higher than static directional stability; the conditions for a stable, neutral or unstable Dutch roll motion; the function of the yaw damper; the actions to be taken when the yaw damper is not available.
Describe how the asymmetric nature of shock waves on both wings, at high Mach numbers, can lead to Dutch roll.
Effects of altitude on dynamic stability
Explain that increased pressure altitude reduces dynamic lateral/directional stability.
CONTROL
General
Basics — The three planes and three axes
Define: lateral axis; longitudinal axis; normal axis.
Define: pitch angle; bank angle (Φ); yaw angle.
Describe the motion about the three axes.
Name and describe the devices that control these motions.

Camber change

State that camber is changed by movement of a control surface and explain the effect.

Angle-of-attack (α) change

Explain the influence of local α change by movement of a control surface.

Pitch (longitudinal) control

Elevator/all-flying tails

Explain the working principle of the elevator/all-flying tail and describe its function.

Downwash effects

Explain the effect of downwash on the tailplane α.

Location of centre of gravity (CG)

Explain the relationship between elevator deflection and CG location to produce a given aeroplane response.

Explain the effect of forward CG limit on pitch control.

Moments due to engine thrust

Describe the effect of engine thrust on pitching moments for different engine locations.

Yaw (directional) control

The rudder

Explain the working principle of the rudder and describe its function. State the relationship between rudder deflection and the moment about the normal axis. Describe the effect of sideslip on the moment about the normal axis.

Rudder limiting

Explain why and how rudder deflection is limited on CAT aeroplanes.

Roll (lateral) control

Ailerons

Explain the functioning of ailerons.

Describe the adverse effects of aileron deflection. (Refer to 081 05 04 04 and 081 06 01 02)

Explain why some aeroplanes have inboard and outboard ailerons.

State that the outboard ailerons are locked beyond a given speed to prevent: over-control; exceeding structural limitations; aeroelastic phenomena (flutter, divergence and aileron reversal).

Describe the use of aileron deflection in normal flight, flight with sideslip, crosswind landings, horizontal turns, flight with one-engine-inoperative.

Define 'roll rate'.

List the factors that affect roll rate.

Describe flaperons and aileron droop.

Spoilers

Explain how spoilers can be used to control the rolling movement in combination with or instead of the ailerons.

Adverse yaw

Explain why the use of ailerons induces adverse yaw.

Means to avoid adverse yaw

Explain how the following reduce adverse yaw: Frise ailerons; differential aileron deflection; rudder aileron cross-coupling; roll spoilers.

Roll/yaw interaction

Explain roll/yaw interaction

Explain the secondary effect of roll.

Explain the secondary effect of yaw.

Means to reduce control forces

Aerodynamic balance

Describe the purpose of aerodynamic balance.

Describe the working principle of the horn balance.

Describe the working principle of the internal balance.

Describe the working principle and application of: balance tab; anti-balance tab; spring tab; servo tab.

Artificial means

State the differences between fully powered controls and power-assisted controls.

Describe power-assisted controls.

Describe the advantages of artificial feel in fully powered control.

Fly-by-wire (FBW)

Control laws

Explain which parameters may be controlled in level flight with the pitch control law.

Explain the advantages of using the CG position in the FBW system

Explain what type of flight-degraded control laws may be available in case of failure.

Explain what are hard and soft protections.

Trimming
Reasons to trim
State the reasons for using trimming devices.
Explain the difference between a trim tab and the various balance tabs.
Trim tabs
Describe the working principle of a trim tab including cockpit indications.
Stabiliser trim
Describe the working principle of a stabiliser trim including the flight deck indications.
Explain the advantages and disadvantages of a stabiliser trim compared to a trim tab.
Explain the relationship between CG position, take-off trim setting, and stabiliser trim position.
Explain the effect of errors in the take-off stabiliser trim setting on the rotation characteristics and stick force during take-off rotation.
Discuss the effects of jammed and runaway stabiliser.
Explain the consequences of jammed stabiliser during take-off, landing, and go-around.
LIMITATIONS
Operating limitations
Flutter
Describe the phenomenon of flutter and how IAS and mass distribution affects the likelihood of flutter occurrence.
Describe the use of mass balance to alleviate the flutter problem by adjusting the mass distribution: wing-mounted engines on pylons; control surface mass balance.
Exlplain what is the flight envelope free of flutter.
Landing gear/flap operating
Describe the reason for flap/landing gear limitations. Define 'V_{LO}'. Define 'V_{LE}'.
Explain why there is a difference between V_{LO} and V_{LE} in the case of some aeroplane types.
Define 'V_{FE}' and describe flap limiting speeds.
Describe flap design features, procedures and warnings to prevent overload.
V_{MO}, V_{NO}, and V_{NE}
Define 'V_{MO}', 'V_{NO}', and 'V_{NE}'.
Explain the significance of V_{MO}, V_{NO} and V_{NE} and the differences between these airspeeds.
Explain the hazards of flying at speeds above V_{NE} and V_{MO}.
M_{MO}
Define 'M_{MO}' and state its limiting factors.
Manoeuvring envelope
Manoeuvring-load diagram
Describe the manoeuvring-load diagram.
Define limit and ultimate load factor, and explain what can happen if these values are exceeded.
Define 'V_A', 'V_B', 'V_C', and 'V_D'.
Identify and explain the varying features on the V_N diagram: load factor 'n'; speed scale, equivalent airspeed; equivalent airspeed envelope; 1g stall speed; stall boundary (refer to 081 03 01 02).
Describe the relationship between V_{MO} or V_{NE} and V_C.
State all the manoeuvring load-factors limits applicable to CS-23 and CS-25 aeroplanes.
Explain the relationship between V_A and V_S in a formula, and calculate the values.
Explain the significance of VA and the adverse consequences of applying full, abrupt nose-up elevator deflection when exceeding VA.
Factors affecting the manoeuvring-load diagram
State the relationship of mass to: load-factor limits and accelerated stall speed boundary limit.
Calculate the change of V_A with changing mass.
Explain why V_A loses significance at higher altitude.
Define 'M_C' and 'M_D'.
Gust envelope
Gust-load diagram
Recognise a typical gust-load diagram, and state the minimum gust speeds in ft/s, m/s and kt that the aeroplane must be designed to withstand at VB to VC and VD.
Discuss considerations for the selection of V_{RA}.
Explain the adverse effects on the aeroplane when flying in turbulence.
Factors affecting the gust-load diagram
Describe and explain the relationship between the gust-load factor and the following: lift-curve slope, aspect ratio, angle of sweep, altitude, wing loading, weight, wing area, equivalent airspeed (EAS), and speed of vertical gust.
(Note: For examination purposes, the ECQB questions will not be calculation based)
PROPELLERS

Conversion of engine torque to thrust

Explain conversion of aerodynamic force on a propeller blade

Explain the resolution of aerodynamic force on a propeller blade element into lift and drag or into thrust and torque.

Describe how propeller thrust and aerodynamic torque vary with IAS.

Relevant propeller parameters

Describe the geometry of a typical propeller blade element at the reference section:

blade chord line;

propeller rotational velocity vector;

true airspeed vector;

blade angle of attack;

pitch or blade angle;

advance or helix angle.

Define 'geometric pitch', 'effective pitch', and 'propeller slip'.

Remark: For theoretical knowledge examination purposes, the following definition is used for geometric pitch: the theoretical distance a propeller would advance in one revolution at zero blade angle of attack.

Describe how the terms 'fine pitch' and 'coarse pitch' can be used to express blade angle.

Blade twist

Define 'blade twist'.

Explain why blade twist is necessary.

Fixed pitch and variable pitch/constant speed

List the different types of propellers: fixed pitch; adjustable pitch or variable pitch (non-governing); variable pitch (governing)/constant speed.

Discuss the advantages and disadvantages of fixed-pitch and constant-speed propellers.

Discuss climb and cruise propellers.

Explain the relationship between blade angle, blade angle of attack, and airspeed for fixed and variable pitch propellers.

Describe and explain the forces that act on a rotating blade element in normal, feathered, windmilling, and reverse operation.

Explain the effects of changing propeller pitch at constant IAS.

Propeller efficiency versus speed

Define 'propeller efficiency'.

Explain and describe the relationship between propeller efficiency and speed (TAS) for different types of propellers.

Explain the relationship between blade angle and thrust.

Effects of ice on propeller

Describe the effects and hazards of ice on a propeller.

Engine failure

Windmilling drag

Describe the effects of an inoperative engine on the performance and controllability of an aeroplane: thrust loss/drag increase; influence on yaw moment during asymmetric power.

Feathering

Explain the reasons for feathering a propeller, including the effect on the yaw moment, performance and controllability.

Design features for power absorption

Propeller design characteristics that increase power absorption

Name the propeller design characteristics that increase power absorption.

Diameter of propeller

Explain the reasons for restricting propeller diameter.

Number of blades

Define 'solidity'.

Describe the advantages and disadvantages of increasing the number of blades.

Propeller noise

Describe how propeller noise can be minimised.

Secondary effects of propellers

Torque reaction

Describe the effects of engine/propeller torque.

Describe the following methods for counteracting engine/propeller torque: counter-rotating propellers; contra-rotating propellers.

Gyroscopic precession

Describe what causes gyroscopic precession.

Describe the effect on the aeroplane due to the gyroscopic effect.

Slipstream effect

Describe the possible effects of the rotating propeller slipstream.

Asymmetric blade effect

Explain the asymmetric blade effect (also called P factor).

Explain the influence of direction of rotation on the critical engine on twin-engine aeroplanes.

Consideration of propeller effects

Describe, given direction of propeller rotation, the propeller effects during take-off run, rotation and initial climb, and their consequence on controllability.

Describe, given the direction of propeller rotation, the propeller effects during a go-around and their consequence on controllability.

Explain how propeller effects during go-around can be affected by: high engine performance conditions and their effect on the VMC speeds; loss of the critical engine; crosswind; high flap setting.

FLIGHT MECHANICS

Forces acting on an aeroplane

Straight, horizontal, steady flight

Describe the forces that act on an aeroplane in straight, horizontal, and steady flight.

List the four forces and state where they act on.

Explain how the four forces are balanced, including the function of the tailplane.

Straight, steady climb

Define 'flight-path angle' (γ).

Describe the relationship between pitch attitude, γ and α for zero-wind and zero-bank conditions.

Describe the forces that act on an aeroplane in a straight, steady climb.

Name the forces parallel and perpendicular to the direction of flight. Apply the formula relating to the parallel forces ($T = D + W \sin \gamma$). Apply the formula relating to the perpendicular forces ($L = W \cos \gamma$).

Explain why thrust is greater than drag.

Explain why lift is less than weight.

Explain the formula (for small angles) that gives the relationship between γ, thrust, weight, and lift-drag ratio, and use this formula for simple calculations.

Explain how IAS, α, and γ change in a climb performed with constant vertical speed and constant thrust setting.

Straight, steady descent

Describe the forces that act on an aeroplane in a straight, steady descent.

Name the forces parallel and perpendicular to the direction of flight. Apply the formula for forces parallel to the direction of flight ($T = D - W \sin \gamma$). Apply the formula relating to the perpendicular forces ($L = W \cos \gamma$).

Explain why lift is less than weight.

Explain why thrust is less than drag.

Straight, steady glide

Describe the forces that act on an aeroplane in a straight, steady glide.

Name the forces parallel and perpendicular to the direction of flight. Apply the formula for forces parallel to the direction of flight ($D = W \sin \gamma$). Apply the formula for forces perpendicular to the direction of flight ($L = W \cos \gamma$).

Describe the relationship between the glide gradient and the lift-drag ratio, and calculate glide range given: initial height; L-D ratio; glide speed and wind speed.

Define V_{MD} (speed for minimum drag) and explain the relationship between α, V_{MD} and the best lift-drag ratio.

Explain the effect of wind component on glide angle, duration, and distance.

Explain the effect of mass change on glide angle, duration, and distance, given that the aeroplane remains at either the same airspeed or at V_{MD}.

Explain the effect of configuration change on glide angle and duration.

Describe the relation between TAS, gradient of descent, and rate of descent.

Define V_{MP} (speed for minimum power) and describe that the minimum rate of descent in the glide will be at VMP, and explain the relationship of this speed to the optimum speed for minimum glide angle.

Discuss when a pilot could elect to fly for minimum glide rate of descent or minimum glide angle, and why speed stability or headwinds/tailwinds may favour a speed that is faster or slower than the optimum airspeed in still air.

Steady, coordinated turn

Describe the forces that act on an aeroplane in a steady, coordinated turn.

Resolve the forces that act horizontally and vertically during a coordinated turn ($\tan Ø = V^2 / gR$).

Describe the difference between a coordinated and an uncoordinated turn, and describe how to correct an uncoordinated turn using turn and slip indicator or turn coordinator.

Explain why the angle of bank is independent of mass, and that it only depends on TAS and radius of turn.

Resolve the forces to show that for a given angle of bank the radius of turn is determined solely by airspeed ($\tan Ø = V^2 / gR$).

Calculate the turn radius of a steady turn given TAS and angle of bank.
Explain the effects of bank angle on: load factor (LF = 1/cos Ø); α; thrust; drag.
Define 'angular velocity'.
Define 'rate of turn' and 'rate-1 turn'.
Explain the influence of TAS on rate of turn at a given bank angle.
Calculate the load factor and stall speed in a turn given angle of bank and 1g stall speed.
Explain situations in which turn radius is relevant for safety, such as maximum speed limits on departure or arrival plates, or outbound speed categories on approach plates, and the implications/hazards of exceeding given speeds.
Describe the hazards of excessive use of rudder to increase the rate of turn in a swept-wing aeroplane.

Asymmetric thrust

Jet-engined and propeller-driven aeroplanes

Describe the effects on the aeroplane of asymmetric thrust during flight, for both jet-engined and propeller-driven aeroplanes.
Explain critical engine, and explain, for a propeller-driven aeroplane, the direction of propeller rotation.
Explain the effect of steady, asymmetric flight on a conventional (ball) slip indicator/turn indicator.
Explain the effect of a crosswind on asymmetric flight.

Balanced moments about the normal axis

Explain the yaw moments about the CG.
Explain the change to the yaw moment caused by the effect of air density on thrust.
Describe the changes to the yaw moment caused by engine distance from CG.
Describe the methods to achieve directional balance following engine loss.

Forces parallel to the lateral axis

Explain: the force on the vertical fin; the fuselage side force due to sideslip (using wing-level method); the use of bank angle to tilt the lift vector (in wing-down method).
Explain the flight hazards at VMC: α; side slip; loads on the fin; α on the fin.
Explain the effect on fin α due to sideslip.

Influence of aeroplane mass

Explain why controllability with one-engine-inoperative is a typical problem arising from the low speeds associated with low aeroplane mass.

Minimum control speed (V_{MC})

Define 'V_{MC}'.
Describe how V_{MC} is determined.
Explain the influence of the CG location.

Minimum control speed during approach and landing (V_{MCL})

Define 'V_{MCL}'.
Describe how V_{MCL} is determined.
Explain the influence of the CG location.

Minimum control speed on the ground (V_{MCG})

Define 'V_{MCG}'.
Describe how V_{MCG} is determined.
Explain the influence of the CG location.

Influence of density

Describe the influence of density on thrust during asymmetric flight.
Explain why V_{MC}, V_{MCL} and V_{MCG} reduce with a reduction in thrust.

Significant points on a polar curve

Identify and explain

Identify and explain the significant points on a polar curve.

090. COMMUNICATIONS

CONCEPTS

Associated terms

Meanings and significance

Define commonly used air traffic services (ATS) terms for stations.
Define commonly used ATS terms for communication methods.
Recognise the terms used in conjunction with the approach and holding procedures.

Air traffic services (ATS) abbreviations

Define commonly used ATS abbreviations: flight conditions; airspace; services; time; VFR-related terms; IFR-related terms; miscellaneous.

Q-code groups commonly used in radiotelephony (RT) air-ground communications

Define Q-code groups commonly used in RT air-ground communications: pressure settings; directions and bearings.
State the procedure for obtaining bearing information in flight.

Categories of messages

Identify to which category of messages a type of message belongs and identify the associated priority indicator.

GENERAL OPERATING PROCEDURES

Transmission standards

Transmission of letters

Know the phonetic alphabet used in RT.

Identify the circumstances when words should be spelt out.

Transmission of numbers

Describe the method of transmission of numbers: pronunciation; single digits, whole hundreds and whole thousands; state how numbers are transmitted in different circumstances.

Transmission of time

Describe the ways of transmitting time: the standard time reference is the Coordinated Universal Time (UTC); using only minutes, or minutes and hours, when required.

Describe the different ways in which time is to be transmitted.

Transmission techniques

Explain the techniques used for making good RT transmissions.

Standard words and phrases

Define the meaning of standard words and phrases.

Recognise, describe and use the correct standard phraseology for each phase of a VFR flight (consider communication with each type of aeronautical station): before taxi; taxi; departure; en route; circuit; final; landing; after landing.

Recognise, describe and use the correct standard phraseology for each phase of an IFR flight, including PBN operations (consider communication with each type of aeronautical station): before pushback or taxi; pushback; taxi; departure; en route; approach; final approach; landing; after landing.

Explain phraseology for the selective calling system (SELCAL) and aircraft communications addressing and reporting system (ACARS).

Explain traffic alert and collision avoidance system (TCAS) phraseology.

RT call signs for aeronautical stations including use of abbreviated call signs

Name the two parts of the call sign of an aeronautical station.

Identify the call-sign suffixes for aeronautical stations.

Explain when the call sign may be omitted or abbreviated to the use of suffix only.

RT call signs for aircraft including use of abbreviated call signs

Describe the three different ways to compose an aircraft call sign.

Describe the abbreviated forms for aircraft call signs.

Explain when aircraft call signs may be abbreviated.

Explain when the suffix 'HEAVY' or 'SUPER' is used with an aircraft call sign.

Explain the use of the phrase 'Change your call sign to…'.

Explain the use of the phrase 'Revert to flight plan call sign'.

Transfer of communication

Describe the procedure for transfer of communication: by ground station; by aircraft.

Test procedures including readability scale

Explain how to test radio transmission and reception.

State the readability scale and explain its meaning.

Read-back and acknowledgement requirements

Describe the requirement to read back ATC route clearances.

Describe the requirement to read back clearances related to the runway in use.

Describe the requirement to read back other clearances including conditional clearances.

Describe the requirement to read back other data such as runway, secondary surveillance radar (SSR) codes, etc.

Radar procedural phraseology

Use the correct phraseology for an aircraft receiving a radar service: radar identification; radar vectoring; traffic information and avoidance; SSR procedures.

Level changes and reports

Use the correct term to describe vertical position in relation to: flight level (standard pressure setting); altitude (metres/feet on QNH); height (metres/feet on QFE).

Data link messages

List the different types of messages of the controller–pilot data link communications (CPDLC) function and give examples of data link messages.

Describe a notification phase (LOG ON) and state its purpose.

Explain the phrases to be used: when voice communication is used to correct a CPDLC message; in case of single CPDLC message failure; when CPDLC has failed; when reverting from CPDLC to voice communication.

RELEVANT WEATHER INFORMATION

Aerodrome weather

Aerodrome weather terms

List the contents of aerodrome weather reports and state units of measurement used for each item: wind direction and speed; variation of wind direction and speed; visibility; present weather; cloud amount and type (including the definition of cloud and visibility OK (CAVOK); air temperature and dew point; pressure values (QNH, QFE); supplementary information (aerodrome warnings, landing runway, runway conditions, restrictions, obstructions, wind-shear warnings, etc.).

Weather broadcast

List the sources (VOLMET and ATIS units) of weather information available for aircraft in flight, and describe situation(s) in which a pilot would normally obtain each.

Explain the meaning of the acronyms 'D-ATIS', 'ATIS', and 'VOLMET'.

Explain and demonstrate how to decode ATIS messages.

Explain and demonstrate how to decode D-ATIS messages.

VOICE COMMUNICATION FAILURE

Required action

Action required to be taken in case of communication failure

State the action to be taken in case of communication failure on a controlled VFR flight.

Identify the frequencies to be used in an attempt to establish communication.

State the additional information that should be transmitted in the event of receiver failure.

Identify the SSR code that may be used to indicate communication failure.

Explain the action to be taken by a pilot that experiences a communication failure in the aerodrome traffic pattern at controlled aerodromes.

Describe the action to be taken in case of communication failure on an IFR flight.

Describe the action to be taken in case of communication failure on an IFR flight when flying in visual meteorological conditions (VMC) and the flight will be terminated in VMC.

Describe the action to be taken in case of communication failure on an IFR flight when flying in instrument meteorological conditions (IMC).

Explain the causes and possible safety impacts of a blocked frequency.

DISTRESS AND URGENCY PROCEDURES

Signals and procedures

Distress

State the DISTRESS signal(s) and DISTRESS procedure(s).

Define 'DISTRESS'.

Identify the frequencies that should be used by aircraft in DISTRESS.

Specify the emergency SSR codes that may be used by aircraft, and the meaning of the codes.

Describe the action to be taken by the station which receives a DISTRESS message.

Describe the action to be taken by all other stations when a DISTRESS procedure is in progress.

List the correctly sequenced elements of a DISTRESS signal/message and describe the message content.

Describe the use of discrete frequencies (DEF) in case of distress or urgency.

State that DISTRESS messages take priority over all other messages.

Urgency

State the URGENCY signal(s) and URGENCY procedure(s).

Define 'URGENCY'.

Identify the frequencies that should be used by aircraft in URGENCY.

Describe the action to be taken by the station which receives an URGENCY message.

Describe the action to be taken by all other stations when an URGENCY procedure is in progress.

List the correctly sequenced elements of an URGENCY signal/message and describe the message content.

State that URGENCY messages take priority over all other messages except DISTRESS.

VHF PROPAGATION AND ALLOCATION OF FREQUENCIES

General principles

Spectrum, bands, range

Describe the radio-frequency spectrum with particular reference to VHF.

Describe the radio-frequency spectrum of the bands into which the radio-frequency spectrum is divided.

Identify the frequency range of the VHF band.

State the band normally used for aeronautical mobile service (AMS) voice communication.

State the frequency separation allocated between consecutive VHF frequencies.

List the factors which reduce the effective range and quality of VHF radio transmissions.

OTHER COMMUNICATIONS

Weather observations, Morse code

Meteorological observations

Explain when aircraft routine meteorological observations should be made.

Explain when aircraft special meteorological observations should be made.

Use of Morse code

Describe and list Morse code.

Find the Morse code identifiers of radio navigation aids (VHF omnidirectional radio range (VOR), distance-measuring equipment (DME), non-directional radio beacon (NDB), instrument landing system (ILS)) using aeronautical charts.

2. MAN - POSSIBILITIES AND RESTRICTIONS - number of lectures / time: 4 hours. (+1 hour online session)

3. METEOROLOGY - number of lectures / time: 10 hours (+2 hours online session)

4. COMMUNICATIONS - number of lectures / time: 3 hours (+1 hour online session)

5. PRINCIPLES OF FLIGHT - number of lectures / time: 12 hours (+2 hours online session)

6. OPERATIONAL PROCEDURES - number of lectures / time: 5 hours. (+1 hour online session)

9. NAVIGATION - number of lectures / time: 10 hours. (+2 hours online session)