European Aviation Safety Agency

Notice of Proposed Amendment 2016-03(D)

Technical review of the theoretical knowledge syllabi, learning objectives, and examination procedures for air transport pilot licence, multi-crew pilot licence, commercial pilot licence, and instrument ratings

Subject 050 — Meteorology

Subject 061 — General navigation

Subject 062 — Radio navigation

RMT.0595 — 9.6.2016

EXECUTIVE SUMMARY

This Notice of Proposed Amendment (NPA) addresses a safety and regulatory coordination issue related to flight crew licensing. It has been developed in response to the European Aviation Safety Plan (EASP) safety actions.

This NPA updates the Learning Objectives (LOs) for the theoretical knowledge (TK) syllabi and ground school examinations, and introduces the threat and error management (TEM) concept and its application. The amendments proposed in this NPA aim to ensure that the LOs correspond to today's operational environment and that commercial pilots are equipped with the knowledge and understanding relevant to modern flight deck and current industry needs. The proposed updated pilot training will contribute to the overall enhancement of the pilots' core competencies and their ability to make informed decisions.

The NPA also introduces new LOs under Area 100 'knowledge, skills and attitudes' (KSA), whose aim is to enhance the pilots' KSA contained in the core competencies. New requirements are proposed for approved training organisations (ATOs) to assess student pilots' KSA. These skills focus on the pilots' ability to apply their knowledge and understanding across subjects and to demonstrate technical and non-technical skills. These LOs will, therefore, not be the subject of examinations organised by the competent authority or its agents, but will be assessed by the ATOs to ensure that trainee pilots have an adequate level of competency before they are allowed to sit their final TK examinations.

The NPA also recommends that EASA develop a process to regularly review and update the LOs so that they are up to date with emerging safety threats as well as with developments in technology and operational practice.

Applicability		**Process map**	
Affected regulations and decisions:	ED Decisions 2011/016/R; 2012/006/R; 2012/007/R; 2014/020/R; 2014/022/R; 2016/008/R	Concept paper:	No
Affected stakeholders:	Competent authorities; ATOs; student pilots; providers of textbooks and training materials; ECQB	Terms of reference:	11.3.2015
Driver/origin:	Safety	Rulemaking group:	Yes
Reference:	EASA 4-year Rulemaking Programme; EASA ECQB Project	RIA type:	Light
		Technical consultation during NPA drafting:	Yes
		Duration of NPA consultation:	3 months
		Review group:	Yes
		Focused consultation:	No
		Publication date of the Opinion:	N/A
		Publication date of the Decision:	2016/Q4

Overview of the proposed amendments to Subject 050 'Meteorology'

The overall structure of Subject 050 'Meteorology' remains unchanged. However, the Learning Objectives (LOs) marked as basic knowledge (BK) form a significant proportion of the meteorology syllabus. The current syllabus for meteorology comprises too many LOs with elementary knowledge on which the practical knowledge was built. To test if the pilot is able to interpret the threats and errors by the meteorological conditions, it is necessary to have questions in the European Central Question Bank (ECQB) about actual phenomena. For this reason, many LOs have been marked as 'BK'.

The changes made confirm that the focus of the theoretical knowledge (TK) examination shifts, particularly for the following parts of the syllabus:

— 050 01 The atmosphere,

— 050 05 Precipitation,

— 050 07 Pressure systems,

— 050 08 Climatology,

— 050 09 Flight hazards — a new syllabus item is added: 'Ice crystal icing'.

Stakeholders are invited to comment on the relevance (practical use) of 050 09 07 00 'Stratospheric conditions', and whether it should be kept on the list of LOs of subject area 050.

A new paragraph '050 09 01 04 Ice crystal icing' has been introduced for the following reason:

Several engine power loss and damage events have occurred in convective weather above the altitudes typically associated with icing conditions. Research has shown that strong convective weather (thunderstorm activity) can lift high concentrations of moisture to high altitudes where it can freeze into very small ice crystals, perhaps as small as 40 microns (the size of flour grains). These crystals can affect an engine when flying through convective weather. Industry is using the phrase 'ice crystal icing' to describe these icing conditions, and to differentiate them from icing conditions due to supercooled liquid.

Ice crystals do not adhere to cold airframe surfaces because the ice crystals bounce off. However, the crystals can partially melt and stick to relatively warm engine surfaces.

SUBJECT 050 — METEOROLOGY

The operation of an aircraft is affected by the weather conditions within the atmosphere. The pilot ~~must~~ should prove that they fulfil the following objectives in order to complete a safe flight in given meteorological conditions.

(1) Training aims

(i) Knowledge. After completion of the training, the pilot ~~must~~ should be able to:

— understand the physical processes in the atmosphere;

— interpret the actual and forecast weather conditions in the atmosphere; and

— ~~show~~ demonstrate understanding of the meteorological hazards and their effects on an aircraft.

(ii) Skills. After completion of the training, the pilot ~~must~~ should be able to:

— collect all the weather information which may affect a given flight;

— analyse and evaluate available weather information before flight as well as that collected in flight; and

— apply a solution to any problems presented by the given weather conditions.

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
050 00 00 00		**METEOROLOGY**								
050 01 00 00		**THE ATMOSPHERE**								
050 01 01 00		**Composition, extent, vertical division**								
050 01 01 01		***Structure of the atmosphere***								
(01)	X	Describe the vertical division of the atmosphere up to flight level (FL) 650, based on the temperature variations with height.	X	X	X	X	X	X		Vertical extension of International Standard Atmosphere (ISA)
(02)	X	List the different layers and their main qualitative characteristics up to FL 650.	X	X	X	X	X	X		
050 01 01 02		***Troposphere***								
(01)	X	Describe the troposphere.	X	X	X	X	X	X		
(02)	X	Describe the main characteristics of the tropopause.	X	X	X	X	X	X		
(03)	X	Describe the proportions of the most important gases in the air in the troposphere.	X	X	X	X	X	X		
(04)	X	Describe the variations of the FL and temperature of the tropopause from the poles to the equator.	X	X	X	X	X	X		
(05)	X	Describe the breaks in the tropopause along the boundaries of the main air masses.	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(06)	X	Indicate the variations of the FL of the tropopause with the seasons and the variations of atmospheric pressure.	X		X	X				
050 01 01 03		***Stratosphere***								
(01)	X	Describe the stratosphere up to FL 650.	X		X	X				
(02)	X	Describe the main differences of the composition of the air in the stratosphere compared to the troposphere.	~~X~~		~~X~~	~~X~~				
~~LO (3)~~		~~Mention the vertical extent of the stratosphere up to the stratopause.~~	~~X~~		~~X~~	~~X~~				No practical use
(04)	X	Describe the reason for the temperature increase in the ozone layer.	~~X~~		~~X~~	~~X~~				
050 01 02 00		**Air temperature**								
050 01 02 01		***Definition and units***								
(01)	X	Define 'air temperature' by kinetic gas theory.	X	X	X	X	X	X		More precise
(02)	X	List the units of measurement of air temperature used in aviation meteorology (Celsius, Fahrenheit, Kelvin). *(Refer to 050 10 01 01)*	X	X	X	X	X	X		
050 01 02 02		***Vertical distribution of temperature***								
(01)	X	Describe the mean vertical distribution of temperature up to ~~20 km~~ FL 650.	X	X	X	X	X	X		Extension of ISA

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(02)	X	Mention the general causes of the cooling of the air in the troposphere with increasing altitude.	X	X	X	X	X	X		
(03)	X	Calculate the temperature and temperature deviations (in relation to ISA) at specified levels.	X	X	X	X	X	X		A reference for deviation is required
050 01 02 03		***Transfer of heat***								
(01)	X	Explain how local cooling or warming processes result in transfer of heat.	X	X	X	X	X	X		
(02)	X	Describe radiation.	X	X	X	X	X	X		
(03)	X	Describe solar radiation reaching the Earth.	X	X	X	X	X	X		
(04)	X	Describe the filtering effect of the atmosphere on solar radiation.	X	X	X	X	X	X		
(05)	X	Describe terrestrial radiation.	X	X	X	X	X	X		
(06)	X	Explain how terrestrial radiation is absorbed by some components of the atmosphere.	X	X	X	X	X	X		
(07)	X	Explain the greenhouse effect due to water vapour and other greenhouse gases ~~some other gases in the atmosphere~~.	X	X	X	X	X	X		The 'other gases' are commonly known as 'greenhouse gases'; water vapour is the most effective greenhouse gas
(08)	X	Explain the effect of absorption and radiation in	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		connection with clouds.								
(09)	X	Explain the process of conduction.	X	X	X	X	X	X		
(10)	X	Explain the role of conduction in the cooling and warming of the atmosphere.	X	X	X	X	X	X		
(11)	X	Explain the process of convection.	X	X	X	X	X	X		
(12)	X	Name the situations in which convection occurs.	X	X	X	X	X	X		
(13)	X	Explain the process of advection.	X	X	X	X	X	X		
(14)	X	Name the situations in which advection occur.	X	X	X	X	X	X		
(15)	X	Describe the transfer of heat by turbulence.	X	X	X	X	X	X		
(16)	X	Describe the transfer of latent heat.	X	X	X	X	X	X		
050 01 02 04		***Lapse rates***								
(01)	X	Describe qualitatively and quantitatively the temperature lapse rates of the troposphere (mean value 0.65 °C/100 m or 2 °C/1 000 ft and actual values).	X	X	X	X	X	X	X	
050 01 02 05		***Development of inversions, types of inversions***								
(01)	X	Describe the development and types of inversions.	X	X	X	X	X	X	X	
(02)	X	Explain the characteristics of inversions and of an isothermal layer concerning stability and vertical motions.	X	X	X	X	X	X	X	
(03)	X	Explain the reasons for the formation of the following	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		inversions: — ground inversion (nocturnal radiation/ advection), subsidence inversion, frontal inversion, inversion above friction layer, valley inversion.								
~~LO (04)~~	~~—~~	~~— Explain the reasons for the formation of the following inversions:~~ ~~— tropopause inversion.~~	~~X~~		~~X~~	~~X~~				No practical use
050 01 02 06		***Temperature near the Earth's surface, insolation, surface effects, ~~diurnal and seasonal variation,~~ effect of clouds, effect of wind***								More precise Deleted, see (01)
(01)		~~Describe how the temperature near the Earth's surface is influenced by seasonal variations.~~ Explain the cooling/warming of the surface of the Earth by radiation.	X	X	X	X	X	X	X	No practical use Radiation as primary cause
(02)	X	Explain the cooling/~~and~~ warming of the air by molecular or turbulent heat transfer to/from ~~on~~ the earth or sea surfaces.	X	X	X	X	X	X	X	More precise
~~LO (03)~~		~~Sketch the diurnal variation of the temperature of the air in relation to the radiation of the sun and of the Earth.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of (01)
(04)	X	Describe qualitatively the influence of the clouds on the cooling and warming of the surface and the air near the surface.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
~~LO (05)~~		~~Distinguish between the influence of low or high clouds and thick or thin clouds.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	X	No practical use
(06)	X	Explain the influence of the wind on the cooling and warming of the air near the surfaces.	X	X	X	X	X	X	X	
050 01 03 00		**Atmospheric pressure**								
050 01 03 01		***Barometric pressure, isobars***								
(01)	X	Define 'atmospheric pressure'.	X	X	X	X	X	X	X	
(02)	X	List the units of measurement of the atmospheric pressure used in aviation (hPa, inches, Mercury). *(Refer to 050 10 01 01)*	X	X	X	X	X	X	X	More precise
~~LO (03)~~		~~Describe the principle of the barometers (mercury barometer, aneroid barometer).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to be examined
(04)	X	~~Describe~~ Define isobars and identify them on surface weather charts.	X	X	X	X	X	X	X	Taxonomy improved to the relevant level
(05)	X	Define 'high', 'low', 'trough', 'ridge', ~~'wedge',~~ 'col'.	X	X	X	X	X	X	X	Not necessary
050 01 03 02		***Pressure variation with height~~, contours (isohypses)~~***								
(01)	X	Explain the pressure variation with height.	X	X	X	X	X	X	X	
(02)	X	Describe ~~qualitatively~~ quantitatively the variation of the barometric lapse rate. *Remark: An approximation of ~~T~~the average value for the*	X	X	X	X	X	X	X	More precise

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		barometric lapse rate near mean sea level (MSL) is ~~27 ft (8 m)~~ 30 ft (9 m) per 1 hPa~~, at about 5 5003000 m (10000ft) /AMSL is 50 ft (15 m) per 1 hPa~~.								50 ft (15 m) per 1 hPa not used by pilots
~~LO (03)~~		~~Describe and interpret contour lines (isohypses) on a constant pressure chart. *(Refer to 050 10 02 03)*~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not used by pilots
(04) New	X	State that (under conditions of ISA) pressure is approximately 50 % of MSL at 18 000 ft and density is approximately 50 % of MSL at 22 000 ft and 25 % of MSL at 40 000 ft.	X	X	X	X	X	X	X	Of practical value
050 01 03 03		***Reduction of pressure to QFF (MSL)***								
(01)	X	Define 'QFF'.	X	X	X	X	X	X	X	
(02)	X	Explain the reduction of measured pressure (QFE) to QFF (MSL).	X	X	X	X	X	X	X	
(03)	X	Mention the use of QFF for surface weather charts.	X	X	X	X	X	X	X	
050 01 03 04		***Relationship between surface pressure centres and pressure centres aloft***								
(01)	X	Illustrate with a vertical cross section of isobaric surfaces the relationship between surface pressure systems and upper-air pressure systems.	X	X	X	X	X	X	X	
050 01 04 00		**Air density**								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
050 01 04 01		***Relationship between pressure, temperature and density***								
(01)	X	Describe the relationship between pressure, temperature and density.	X	X	X	X	X	X	X	
(02)	X	Describe the vertical variation of the air density in the atmosphere.	X	X	X	X	X	X	X	
~~LO (03)~~		~~Describe the effect of humidity changes on the density of air.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use Humidity is covered in 050 03 01 00
050 01 05 00		**~~ICAO~~ International Standard Atmosphere (ISA)**								
050 01 05 01		***~~ICAO~~ International Standard Atmosphere (ISA)***								
(01)	X	Explain the use of standardised values for the atmosphere.	X	X	X	X	X	X	X	
(02)	X	List the main values of the ISA MSL pressure, MSL temperature, the vertical temperature lapse rate up to ~~20 km~~ FL 650, height and temperature of the tropopause).	X	X	X	X	X	X	X	In all LOs, 20 km have been changed to FL 650
~~LO (03)~~		~~Calculate the standard temperature in Celsius for a given flight level.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of 050 01 02 02 (03)
~~LO (04)~~		~~Determine a standard temperature deviation by the difference between the given outside-air temperature and the standard temperature.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of 050 01 02 02 (03)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
050 01 06 00		**Altimetry**								
050 01 06 01		***Terminology and definitions***								
(01)		Define the following terms ~~and acronyms~~ and explain how they are related to each other: height, altitude, pressure altitude, flight level, pressure level, true altitude, true height, elevation, QNH, QFE and standard altimeter setting.	X	X	X	X	X	X	X	No acronyms More precise
(02)		Describe the terms 'transition altitude', 'transition level', 'transition layer', 'terrain clearance', 'lowest usable flight level'.	X	X	X	X	X	X	X	
050 01 06 02		***Altimeter settings***								
(01)		Name the altimeter settings associated to height, altitude, pressure altitude and flight level.	X	X	X	X	X	X		
(02)		Describe the altimeter-setting procedures.	X	X	X	X	X	X		
050 01 06 03		***Calculations***								
(01)		Calculate the different readings on the altimeter when the pilot changes the altimeter setting.	X	X	X	X	X	X	X	
(02)		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.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(03)		Derive the reading of the altimeter of an aircraft on the ground when the pilot uses the different settings.	X	X	X	X	X	X	X	
(04)		Explain the influence of the air temperature on the distance between the ground and the level read on the altimeter and between two flight levels.	X	X	X	X	X	X	X	
(05)		Explain the influence of pressure areas on true altitude.	X	X	X	X	X	X	X	
(06)		Determine the true altitude/height for a given altitude/height and a given ISA temperature deviation.	X	X	X	X	X	X	X	
(07)		Calculate the terrain clearance and the lowest usable flight level for given atmospheric temperature and pressure conditions.	X	X	X	X	X	X	X	
(08) New		State that the 4 %-rule can be used to calculate true altitude from indicated, and also indicated from true altitude (not precise but sufficient due to the approximation of the 4%-rule.)	X	X	X	X	X	X	X	Practical application
		Remark: The following rules should be considered for altimetry calculations: *a) All calculations are based on rounded pressure values to the nearest lower hPa;* *b) ~~The value for the barometric lapse rate near mean sea level is is 27 ft (8 m)30 ft (9m)per 1 hPa;~~* *In ISA, and between 1013.25 and 700 hPa, 30 ft/hPa is an*								More precise

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		acceptable approximation of the barometric lapse rate. *c) To determine the true altitude/height, the following rule of thumb, called the '4 %-rule', shall be used: the altitude/height changes by 4 % for each 10 °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 airport 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.*								
050 01 06 04		***Effect of accelerated airflow due to topography***								
(01)		Describe qualitatively how the effect of accelerated airflow due to topography (the Bernoulli effect) affects altimetry.	X	X	X	X	X	X	X	
050 02 00 00		**WIND**								
050 02 01 00		**Definition and measurement of wind**								
050 02 01 01		***Definition and measurement***								
(01)	X	Define 'wind' and 'surface wind'.	X	X	X	X	X	X		Both terms are used

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(02)	X	State the units of wind direction and speed (kt, m/s, km/h). ~~*(Refer to 050 10 01 01)*~~	X	X	X	X	X	X		The related LO is deleted
(03)		~~Explain~~ Describe how wind is measured ~~in meteorology~~.	X	X	X	X	X	X		Better taxonomy, more precise
050 02 02 00		**Primary cause of wind**								
050 02 02 01		***Primary cause of wind, pressure gradient, Coriolis force~~, gradient wind~~***								See deletion of 050 02 02 01 (07)
(01)	X	Define the term 'horizontal pressure gradient'.	X	X	X	X	X	X		
(02)	X	Explain how the pressure gradient force acts in relation to the pressure gradient.	X	X	X	X	X	X		
(03)	X	Explain how the Coriolis force acts in relation to the wind.	X	X	X	X	X	X		
(04)	X	Explain the development of the geostrophic wind.	X	X	X	X	X	X		
(05)	X	Indicate how the geostrophic wind flows in relation to the isobars~~/isohypses~~ in the northern and in the southern hemisphere.	X	X	X	X	X	X		Isohypses have been deleted in a previous LO
(06)	X	Analyse the effect of changing latitude on the geostrophic wind speed.	X		X	X				
~~LO (07)~~		~~Explain the gradient wind effect and indicate how the gradient wind differs from the geostrophic wind in~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		The difference is of no practical value

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		~~cyclonic and anticyclonic circulation.~~								
050 02 02 02		***Variation of wind in the friction layer***								
(01)		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).	X	X	X	X	X	X	X	
(02)		State the surface and air-mass conditions that influence the wind in the friction layer (diurnal variation).	X	X	X	X	X	X		
(03)		Name the factors that influence the vertical extent of the friction layer.	X	X	X	X	X	X		
(04)		Explain the relationship between isobars and wind (direction and speed).	X	X	X	X	X	X	X	
		Remark: 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 % of the geostrophic wind* / *The wind in the friction layer blows across the isobars towards the low pressure. Angle between wind direction and isobars.*								

Syllabus reference	BK	Syllabus details and associated Learning Objectives			Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
					ATPL	CPL	ATPL /IR	ATPL	CPL			
		over water	*ca 70 %*	*ca 10°*								
		over land	*ca 50 %*	*ca 30°*								
		WMO-NO. 266										
050 02 02 03		***Effects of convergence and divergence***										
(01)	X	Describe atmospheric convergence and divergence.			X	X	X	X	X	X	X	
(02)	X	Explain the ~~effect of~~ 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).			X	X	X	X	X	X	X	More general understanding (includes 'effect of…')
050 02 03 00		**General global circulation**										
050 02 03 01		***General circulation around the globe***										
(01)		Describe ~~and explain~~ the general global circulation. *(Refer to 050 08 01 01)*			X	X	X	X	X	X		…is sufficient
(02)		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.			X		X	X				
(03)		Sketch or indicate on a map the westerly and easterly tropospheric winds at high level in January and July.			X		X	X				
050 02 04 00		**Local winds**										

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
050 02 04 01		***Anabatic and katabatic winds, mountain and valley winds, Venturi effects, land and sea breezes***								
(01)		Describe and explain anabatic and katabatic winds.	X	X	X	X	X	X	X	
(02)		Describe ~~and explain~~ mountain and valley winds.	X	X	X	X	X	X	X	…is sufficient
(03)		Describe ~~and explain~~ the Venturi effect, convergence in valleys and mountain areas.	X	X	X	X	X	X	X	…is sufficient
(04)		Describe ~~and explain~~ land and sea breezes, sea-breeze front.	X	X	X	X	X	X	X	…is sufficient
050 02 05 00		**Mountain waves (standing waves, lee waves)**								
050 02 05 01		***Origin and characteristics***								
(01)		Explain the origin and formation of mountain waves.	X	X	X	X	X	X	X	Taxonomy
(02)	X	State the conditions necessary for the formation of mountain waves.	X	X	X	X	X	X	X	
(03)		Describe the structure and properties of mountain waves.	X	X	X	X	X	X	X	
(04)		Explain how mountain waves may be identified by their associated meteorological phenomena.	X	X	X	X	X	X	X	
050 02 06 00		**Turbulence**								
050 02 06 01		***Description and types of turbulence***								
(01)	X	Describe turbulence and gustiness.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(02)		List the common types of turbulence (convective, mechanical, orographic, frontal, clear air turbulence).	X	X	X	X	X	X	X	
050 02 06 02		***Formation and location of turbulence***								
(01)	X	Explain the formation of convective turbulence, mechanical and orographic turbulence, frontal turbulence~~, clear air turbulence~~.	X	X	X	X	X	X	X	See 050 02 06 03
(02)		State where turbulence will normally be found (rough-ground surfaces, relief, inversion layers, cumulonimbus (CB), thunderstorm (TS) zones, unstable layers).	X	X	X	X	X	X	X	
050 02 06 03		***Clear air turbulence (CAT) — description, cause and location***								
(01)		Describe ~~the term~~ CAT.	X	X	~~X~~	~~X~~	~~X~~	X		Better wording
(02)		~~Explain~~ Describe the formation of CAT.	X	X	X	X	X	X		Taxonomy
(03)		State where CAT is found in association with jet streams, in high-level troughs and in other disturbed high-level air flows. *(Refer to 050 09 02 02)*	X		~~X~~	~~X~~				
050 02 07 00		**Jet streams**								
050 02 07 01		***Description***								
(01)		Describe jet streams.	X	X	~~X~~	~~X~~	~~X~~	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(02)		State the defined minimum speed of a jet stream (60 kt).	X	X	~~X~~	~~X~~	~~X~~	X		The definition
(03)		State the typical figures for the dimensions of jet streams.	X	X	~~X~~	~~X~~	~~X~~	X		
050 02 07 02		***Formation and properties of jet streams***								
(01)		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.	X	X	~~X~~	~~X~~				
050 02 07 03		***Location of jet streams and associated CAT areas***								
(01)		Sketch or describe where polar front and arctic jet streams are found in the troposphere in relation to the tropopause and to fronts.	X		~~X~~	~~X~~				
~~LO (02)~~		~~Sketch or describe the isotherms, the isotachs, the pressure surfaces and the movements of air in a cross section of a polar front jet stream.~~	~~X~~		~~X~~	~~X~~				Too detailed
(03)		Describe and indicate the areas of worst wind shear and CAT.	X		~~X~~	~~X~~				
050 02 07 04		***~~Jet stream recognition~~ Intentionally left blank***								
~~LO (01)~~		~~State how jet streams may be recognised from their associated meteorological phenomena~~.	~~X~~		~~X~~	~~X~~				No practical use

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
050 03 00 00		**THERMODYNAMICS**								
050 03 01 00		**Humidity**								
050 03 01 01		***Water vapour in the atmosphere***								
(01)	X	~~Describe humid air.~~ State that the density of moist air is less than the density of dry air.	X	X	X	X	X	X	X	Old LO is trivial
(02)	X	Describe the significance for meteorology of water vapour in the atmosphere.	X	X	X	X	X	X	X	
(03)	X	Indicate the sources of atmospheric humidity.	X	X	X	X	X	X	X	
(04) New	X	Define 'saturation of air by water vapour'.	X	X	X	X	X	X		Moved from 050 03 01 02 (05)
050 03 01 02		~~***Mixing ratio***~~ ***Intentionally left blank***								
~~LO (01)~~		~~Define 'mixing ratio' and 'saturation mixing ratio'.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (02)~~		~~Name the unit used in meteorology to express the mixing ratio (g/kg).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (03)~~		~~Explain the factors influencing the mixing ratio.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (04)~~		~~Recognise the lines of equal mixing ratio on a simplified diagram (T, P).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (05)~~	~~X~~	~~Define 'saturation of air by water vapour'.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to 050 03 01 01
~~LO (06)~~		~~Illustrate with a diagram (T, mixing ratio) the influence of~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		~~the temperature on the saturation mixing ratio, at constant pressure.~~								
~~LO (07)~~		~~Explain the influence of the pressure on the saturation mixing ratio.~~ ~~*Remark: A simplified diagram (T,P) contains:*~~ ~~— *on the x-axis: temperature (T);*~~ ~~— *on the y-axis: height corresponding to pressure (P).*~~ ~~*The degree of saturation/mixing ratio and stability/instability are shown as functions of temperature change with height (as lines or curves in the diagram).*~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
050 03 01 03		***Temperature/dew point, relative humidity***								
(01)	X	Define ‘dew point’.	X	X	X	X	X	X	X	
~~LO (02)~~		~~Recognise the dew-point curve on a simplified diagram (T, P).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use
(03)	X	Define ‘relative humidity’.	X	X	X	X	X	X	X	
(04)	X	Explain the factors influencing the relative humidity at constant pressure.	X	X	X	X	X	X	X	
(05)	X	Explain the diurnal variation of the relative humidity.	X	X	X	X	X	X	X	
~~LO (06)~~		~~Describe the relationship between relative humidity, the amount of water vapour and the temperature~~.	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of 050 03 01 03 (03)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(07)	X	Describe the relationship between temperature and dew point.	X	X	X	X	X	X	X	
(08)		Estimate the relative humidity of the air from the difference between dew point and temperature.	X	X	X	X	X	X	X	
050 03 02 00		**Change of state of aggregation**								
050 03 02 01		***Condensation, evaporation, sublimation, freezing and melting, latent heat***								
(01)	X	Define 'condensation', 'evaporation', 'sublimation', 'deposition', 'freezing and melting' and 'latent heat'.	X	X	X	X	X	X		For completeness
(02)	X	List the conditions for condensation/evaporation.	X	X	X	X	X	X		
(03)	X	Explain the condensation process.	X	X	X	X	X	X		
(04)	X	Explain the nature of and the need for condensation nuclei.	X	X	X	X	X	X		
(05)	X	Explain the effects of condensation on the weather.	X	X	X	X	X	X		
(06)	X	List the conditions for freezing/melting.	X	X	X	X	X	X		
(07)	X	Explain the process of freezing.	X	X	X	X	X	X		
(08)	X	Explain the nature of and the need for freezing nuclei.	X	X	X	X	X	X		
(09)	X	Define 'supercooled water'. *(Refer to 050 09 01 01)*	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(10)	X	List the conditions for sublimation/deposition.	X	X	X	X	X	X		See 050 03 02 01 (01)
(11)	X	Explain the sublimation/deposition process.	X	X	X	X	X	X		See 050 03 02 01 (01)
(12)	X	Explain the nature of and the need for sublimation nuclei.	X	X	X	X	X	X		
(13)	X	Describe the absorption or release of latent heat in each change of state of aggregation.	X	X	X	X	X	X		
~~LO (14)~~		~~Explain the influence of atmospheric pressure, the temperature of the air and of the water or ice on the changes of state of aggregation.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know
(15)		Illustrate all the changes of state of aggregation with practical examples.	X	X	X	X	X	X		
050 03 03 00		**Adiabatic processes**								
050 03 03 01		***Adiabatic processes, stability of the atmosphere***								
~~LO (01)~~		~~Describe the adiabatic processes~~.	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Duplication of 050 03 03 01 (02) and (07)
(02)	X	Describe the adiabatic process in an unsaturated rising or descending air particle.	X	X	X	X	X	X		
(03)	X	Explain the variation of temperature of a rising/ descending unsaturated air particle. ~~with changing altitude.~~	X	X	X	X	X	X		
~~LO (04)~~		~~Explain the changes which take place in mixing ratio with~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		~~changing altitude.~~								
(05)	X	~~Explain the changes which take place in relative humidity with changing altitude.~~ Explain the variation of humidity of a rising/descending unsaturated air particle	X	X	X	X	X	X		
~~LO (06)~~		~~Use the dry adiabatic and mixing ratio lines on a simplified diagram (T, P) for a climbing or descending air particle.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know
(07)	X	Describe the adiabatic process in a saturated rising or descending air particle.	X	X	X	X	X	X		
(08)		Explain the variation of temperature of a saturated air particle with changing altitude.	X	X	X	X	X	X		More precise
~~LO (09)~~		~~Explain the difference in temperature lapse rate between saturated and unsaturated air.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Duplication of 050 03 03 01 (02) and (07)
~~LO (10)~~		~~Explain the influence of different air temperatures on the temperature lapse rate in saturated air.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know
~~LO (11)~~		~~Use the saturated adiabatic lines on a simplified diagram (T, P) for a climbing or descending air particle.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know
~~LO (12)~~		~~Find the condensation level, or base of the clouds, on a simplified diagram (T, P).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(13)	X	Explain the static stability of the atmosphere using the actual temperature curve with reference to the adiabatic lapse rates.	X	X	X	X	X	X		Reference necessary
(14)		Define qualitatively and quantitatively the terms 'stability', 'conditional instability', 'instability' and 'indifferent (neutral)'.	X	X	X	X	X	X		
~~LO (15)~~		~~Explain with a sketch on a simplified diagram (T, P) the different possibilities of atmospheric stability: absolute stability, absolute instability, conditional instability and indifferent (neutral).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know
~~LO (16)~~		~~Illustrate with a sketch of the adiabatic lapse rates and the vertical temperature profile of the atmosphere the effect of an inversion on the vertical motion of air.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know
~~LO (17)~~		~~Illustrate with a schematic sketch of the saturated adiabatic lapse rate and the vertical temperature profile the instability inside a cumuliform cloud.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know
~~LO (18)~~		~~Illustrate with a schematic sketch the formation of the subsidence inversion.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Too detailed info without relevance
(19)		Illustrate with a schematic sketch the formation of Foehn.	X	X	X	X	X	X		
(20)		Explain the effect on the stability of the air caused by advection of air (warm or cold).	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		Remark: Dry adiabatic lapse rate = 1 °C/100 m or 3 °C/1 000 ft; average value at lower levels for saturated adiabatic lapse rate = 0.6 °C/100 m or 1.8 °C/1 000 ft (values to be used in examinations).								
050 04 00 00		**CLOUDS AND FOG**								
050 04 01 00		**Cloud formation and description**								
050 04 01 01		***Cloud formation***								
(01)	X	Explain cloud formation by adiabatic cooling, conduction, advection and radiation.	X	X	X	X	X	X	X	
(02)	X	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.	X	X	X	X	X	X	X	
~~LO (03)~~		~~Determine cloud base and top in a simplified diagram (temperature, pressure, humidity).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
~~LO (04)~~		~~Explain the influence of relative humidity on the height of the cloud base.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
~~LO (05)~~		~~Illustrate in a thermodynamic diagram the meaning of convective temperature (temperature at which formation of cumulus starts).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
(06)		List cloud types typical for stable and unstable air	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		conditions.								
(07)	X	Summarise the conditions for the dissipation of clouds.	X	X	X	X	X	X	X	
050 04 01 02		***Cloud types and cloud classification***								
(01)	X	Describe the different cloud types and ~~cloud~~ their classification.	X	X	X	X	X	X	X	Better wording
(02)		Identify by shape cirriform, cumuliform and stratiform clouds.	X	X	X	X	X	X	X	
(03)		Identify by shape and typical level the 10 cloud types (genera).	X	X	X	X	X	X	X	
(04)		Describe and identify by shape the following species and supplementary features: *castellanus, lenticularis, fractus, humilis, mediocris, congestus, calvus, capillatus* and *virga*.	X	X	X	X	X	X	X	
(05)	X	Distinguish between low-, medium- and high-level clouds according to the World Meteorological Organization's (WMO) 'cloud etage'. ~~(including heights): for mid latitudes.~~	X	X	X	X	X	X	X	Combined with 050 04 01 02 (06)
~~LO (06)~~	—	— ~~Distinguish between low, medium and high-level clouds according to the WMO 'cloud etage' (including heights):~~ — ~~for all latitudes.~~	~~X~~		~~X~~	~~X~~			~~X~~	Combined with 050 04 01 02 (05)
(07)		Distinguish between ice clouds, mixed clouds and pure-	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		water clouds.								
050 04 01 03		***Influence of inversions on cloud development***								
(01)	X	Explain the influence of inversions on vertical movements in the atmosphere.	X	X	X	X	X	X	X	
(02)	X	Explain the influence of an inversion on the formation of stratus clouds.	X	X	X	X	X	X	X	
(03)		Explain the influence of ground inversion on the formation of fog.	X	X	X	X	X	X	X	
(04)	X	Determine on a simplified diagram the top of a cumulus cloud caused by an inversion.	X	X	X	X	X	X	X	
(05)		Describe the role of the tropopause inversion with regard to the formation of clouds.	X	X	X	X				
050 04 01 04		***Flying conditions in each cloud type***								
(01)		Assess the 10 cloud types for icing and turbulence.	X	X	X	X	X	X	X	
050 04 02 00		**Fog, mist, haze**								
050 04 02 01		***General aspects***								
(01)	X	Define 'fog', ~~'mist' and 'haze'~~ with reference to the WMO standards of visibility range.	X	X	X	X	X	X	X	Mist and haze not referenced in WMO
(02) New	X	Define 'mist' and 'haze'.	X	X	X	X	X	X	X	See 050 04 02 01 (01)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(03)	X	Explain the formation of fog, mist and haze in general.	X	X	X	X	X	X	X	
(04)		Name the factors contributing in general to the formation of fog and mist.	X	X	X	X	X	X	X	
(05)		Name the factors contributing to the formation of haze.	X	X	X	X	X	X	X	
(06)		Describe freezing fog and ice fog.	X	X	X	X	X	X	X	
050 04 02 02		***Radiation fog***								
(01)	X	Explain the formation of radiation fog.	X	X	X	X	X	X	X	
~~LO (02)~~		~~Explain the conditions for the development of radiation fog.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of 050 04 02 02 (01)
(03)		Describe the significant characteristics of radiation fog, and its vertical extent.	X	X	X	X	X	X	X	
(04)		Summarise the conditions for the dissipation of radiation fog.	X	X	X	X	X	X	X	
050 04 02 03		***Advection fog***								
(01)	X	Explain the formation of advection fog.	X	X	X	X	X	X	X	
~~LO (02)~~		~~Explain the conditions for the development of advection fog.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of 050 04 02 03 (01)
(03)		Describe the different possibilities of advection-fog formation (over land, sea and coastal regions).	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(04)		Describe the significant characteristics of advection fog.	X	X	X	X	X	X	X	
(05)		Summarise the conditions for the dissipation of advection fog.	X	X	X	X	X	X	X	
050 04 02 04		***Steam fog***								
(01)	X	Explain the formation of steam fog.	X	X	X	X	X	X	X	
(02)		Explain the conditions for the development of steam fog.	X	X	X	X	X	X	X	
~~LO (03)~~		~~Describe the significant characteristics of steam fog.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of 050 04 02 04 (01)
(04)		Summarise the conditions for the dissipation of steam fog.	X	X	X	X	X	X	X	
050 04 02 05		***Frontal fog***								
(01)	X	Explain the formation of frontal fog.	X	X	X	X	X	X	X	
~~LO (02)~~		~~Explain the conditions for the development of frontal fog.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of 050 04 02 05 (01)
(03)		Describe the significant characteristics of frontal fog.	X	X	X	X	X	X	X	
(04)		Summarise the conditions for the dissipation of frontal fog.	X	X	X	X	X	X	X	
050 04 02 06		***Orographic fog (hill fog)***								
(01)		Summarise the features of orographic fog.	X	X	X	X	X	X	X	
~~LO (02)~~		~~Explain the conditions for the development of orographic~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		~~fog.~~								050 04 02 06 (01)
(03)	X	Describe the significant characteristics of orographic fog.	X	X	X	X	X	X	X	
(04)		Summarise the conditions for the dissipation of orographic fog.	X	X	X	X	X	X	X	
050 05 00 00		**PRECIPITATION**								
050 05 01 00		**Development of precipitation**								
050 05 01 01		***Process of development of precipitation***								
~~LO (01)~~		~~Distinguish between the two following processes by which precipitation is formed.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	X	Not necessary to know
~~LO (02)~~		~~Summarise the outlines of the ice crystal process (Wegener-Bergeron-Findeisen).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
~~LO (03)~~		~~Summarise the outlines of the coalescence process.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
~~LO (04)~~		~~Describe the atmospheric conditions that favour either process.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
(05)	X	Explain the development of snow, rain, drizzle and hail.	X	X	X	X	X	X	X	
050 05 02 00		**Types of precipitation**								
050 05 02 01		***Types of precipitation, relationship with cloud types***								
(01)		List and describe the types of precipitation given in the aerodrome forecast (TAF) and aerodrome routine	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		meteorological report (METAR) codes (drizzle, rain, snow, snow grains, ice pellets, hail, small hail, snow pellets, ice crystals, freezing drizzle, freezing rain).								
(02)		State the ICAO/WMO approximate diameters for cloud, drizzle and rain drops.	X	X	X	X	X	X	X	
(03)		~~State the approximate weights and diameters for hailstones.~~ State that, because of their size, hail stones can cause significant damage to aeroplanes.	X	X	X	X	X	X	X	More practice-orientated
(04)	X	Explain the mechanism for the formation of freezing precipitation.	X	X	X	X	X	X	X	
(05)		Describe the weather conditions that give rise to freezing precipitation.	X	X	X	X	X	X		
(06)		Distinguish between the types of precipitation generated in convective and stratiform cloud.	X	X	X	X	X	X	X	
(07)		Assign typical precipitation types and intensities to different cloud types.	X	X	X	X	X	X	X	More precise
050 06 00 00		**AIR MASSES AND FRONTS**								
050 06 01 00		**Air masses**								
050 06 01 01		***Description, classification and source regions of air masses***								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(01)		Define the term 'air mass'.	X	X	X	X	X	X	X	
(02)		Describe the properties of the source regions.	X	X	X	X	X	X	X	
(03)	X	Summarise the classification of air masses by source regions.	X	X	X	X	X	X	X	
(04)		State the classifications of air masses by temperature and humidity at source.	X	X	X	X	X	X	X	
(05)		State the characteristic weather in each of the air masses.	X	X	X	X	X	X	X	
(06)		Name the three main air masses that affect Europe.	X	X	X	X	X	X	X	
(07)		Classify air masses on a surface weather chart.	X	X	X	X	X	X	X	
		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*								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		• *cold (c),* • *warm (w).*								
050 06 01 02		***Modifications of air masses***								
(01)		List the environmental factors that affect the final properties of an air mass.	X	X	X	X	X	X	X	
(02)		Explain how maritime and continental tracks modify air masses.	X	X	X	X	X	X	X	
(03)		Explain the effect of passage over cold or warm surfaces.	X	X	X	X	X	X	X	
(04)		Explain how air-mass weather is affected by the season, the air-mass track and by orographic and thermal effects over land.	X	X	X	X	X	X	X	
(05)		Assess the tendencies of the stability for an air mass and describe the typical resulting air-mass weather including the hazards for aviation.	X	X	X	X	X	X	X	
050 06 02 00		**Fronts**								
050 06 02 01		***General aspects***								
(01)		Describe the boundaries between air masses (fronts).	X	X	X	X	X	X	X	
(02)	X	Define ‘front’ and ~~frontal surface (~~‘frontal zone’~~)~~.	X	X	X	X	X	X	X	To avoid confusion
(03)	X	Name the global frontal systems (P~~p~~olar front, A~~a~~rctic front).	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
~~LO (03)~~		~~State the approximate seasonal latitudes and geographic positions of the polar front and the arctic front.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know
050 06 02 02		***Warm front, associated clouds and weather***								
(01)	X	Define a 'warm front'.	X	X	X	X	X	X	X	
(02)		Describe the cloud, weather, ground visibility and aviation hazards at a warm front depending on the stability of the warm air.	X	X	X	X	X	X	X	
~~LO (03)~~		~~Explain the seasonal differences in the weather at warm fronts.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
(04)	X	Describe the structure, slope and dimensions of a warm front.	X	X	X	X	X	X	X	
(05)		Sketch a cross section of a warm front showing weather, cloud and aviation hazards.	X	X	X	X	X	X	X	
050 06 02 03		***Cold front, associated clouds and weather***								
(01)	X	Define a 'cold front'.	X	X	X	X	X	X	X	
(02)		Describe the cloud, weather, ground visibility and aviation hazards at a cold front depending on the stability of the warm air.	X	X	X	X	X	X	X	
~~LO (03)~~		~~Explain the seasonal differences in the weather at cold fronts.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(04)	X	Describe the structure, slope and dimensions of a cold front.	X	X	X	X	X	X	X	
(05)		Sketch a cross section of a cold front showing weather, cloud and aviation hazards.	X	X	X	X	X	X	X	
050 06 02 04		***Warm sector, associated clouds and weather***								
(01)	X	~~Define~~ Describe fronts and air masses associated with the warm sector.	X	X	X	X	X	X	X	
(02)		Describe the cloud, weather, ground visibility and aviation hazards in a warm sector.	X	X	X	X	X	X	X	
~~LO (03)~~		~~Explain the seasonal differences in the weather in the warm sector.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
(04)		Sketch a cross section of a warm sector showing weather, cloud and aviation hazards.	X	X	X	X	X	X	X	
050 06 02 05		***Weather behind the cold front***								
(01)		Describe the cloud, weather, ground visibility and aviation hazards behind the cold front.	X	X	X	X	X	X	X	
~~LO (02)~~		~~Explain the seasonal differences in the weather behind the cold front.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
050 06 02 06		***Occlusions, associated clouds and weather***								
(01)	X	Define the term ‘occlusion’.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(02)	X	Define a 'cold occlusion'.	X	X	X	X	X	X	X	
(03)	X	Define a 'warm occlusion'.	X	X	X	X	X	X	X	
~~LO (04)~~		~~Describe the cloud, weather, ground visibility and aviation hazards in a cold occlusion.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
~~LO (05)~~		~~Describe the cloud, weather, ground visibility and aviation hazards in a warm occlusion.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
~~LO (06)~~		~~Explain the seasonal differences in the weather at occlusions.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
(07)		Sketch a cross section of cold and warm occlusions showing weather, cloud and aviation hazards.	X	X	X	X	X	X		
(08)		On a sketch illustrate the development of an occlusion and the movement of the occlusion point.	X	X	X	X	X	X	X	
050 06 02 07		***Stationary front, associated clouds and weather***								
(01)	X	Define a 'stationary ~~or quasi-stationary~~ front'.	X	X	X	X	X	X	X	Term "quasi-stationary" not defined
(02)		Describe the cloud, weather, ground visibility and aviation hazards in a stationary or quasi-stationary front.	X	X	X	X	X	X	X	
050 06 02 08		***Movement of fronts and pressure systems, life cycle***								
(01)		Describe the movements of fronts and pressure systems and the life cycle of a mid-latitude depression.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(02)		State the rules for predicting the direction and the speed of movement of fronts.	X	X	X	X	X	X	X	
(03)	X	~~Explain~~ State the difference between the speed of movement of cold and warm fronts.	X	X	X	X	X	X	X	
(04)		State the rules for predicting the direction and the speed of movement of frontal depressions.	X	X	X	X	X	X	X	
(05)		Describe, with a sketch if required, the genesis, development and life cycle of a frontal depression with associated cloud and rain belts.	X	X	X	X	X	X	X	
050 06 02 09		***Changes of meteorological elements at a frontal wave***								
(01)		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.	X	X	X	X	X	X	X	
050 07 00 00		**PRESSURE SYSTEMS**								
050 07 01 00		**The principal pressure areas**								
050 07 01 01		***Location of the principal pressure areas***								
(01)		Identify or indicate on a map the principal global high-pressure and low-pressure areas in January and July.	X		X	X				
(02)	X	Explain how these pressure areas are formed.	X		X	X				

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(03)		Explain how the pressure areas move with the seasons.	X		X	X				
050 07 02 00		**Anticyclone**								
050 07 02 01		***Anticyclones, types, general properties, cold and warm anticyclones, ridges and ~~wedges,~~ subsidence***								No practical value
~~LO (01)~~		~~List the different types of anticyclones.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
(02)	X	Describe the effect of high-level convergence in producing areas of high pressure at ground level.	X	X	X	X	X	X	X	
(03)	X	Describe air-mass subsidence, its effect on the environmental lapse rate, and the associated weather.	X	X	X	X	X	X	X	
~~LO (04)~~		~~Describe the formation of warm and cold anticyclones.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	X	Not necessary to know
(05)	X	Describe the formation of ridges ~~and wedges~~. ~~*(Refer to 050 08 03 02)*~~	X	X	X	X	X	X	X	Duplicate Reference LO is deleted
(06)		Describe the properties of and the weather associated with warm and cold anticyclones.	X	X	X	X	X	X	X	
(07)		Describe the properties of and the weather associated with ridges ~~and wedges~~.	X	X	X	X	X	X	X	
(08)	X	Describe the blocking anticyclone and its effects.	X	X	X	X	X	X	X	
050 07 03 00		**Non-frontal depressions**								
050 07 03 01		***Thermal, orographic, polar and secondary depressions;***								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		troughs								
(01)	X	Describe the effect of high-level divergence in producing areas of low pressure at ground level.	X	X	X	X	X	X	X	
(02)	X	Describe the formation and properties of thermal, orographic (lee lows), polar and secondary depressions.	X	X	X	X	X	X	X	
(03)		Describe the formation, the properties and the associated weather of troughs.	X	X	X	X	X	X	X	
050 07 04 00		**Tropical revolving storms**								
050 07 04 01		***Characteristics of tropical revolving storms***								
(01)	X	State the conditions necessary for the formation of tropical revolving storms.	X		X	X				
(02)		Explain how a tropical revolving storm moves during its life cycle.	X		X	X				
(03)		Name the stages of the development of tropical revolving storms (tropical disturbance, tropical depression, tropical storm, severe tropical storm, tropical revolving storm).	X		X	X				
(04)		Describe the meteorological conditions in and near a tropical revolving storm.	X		X	X				
(05)		State the approximate dimensions of a tropical revolving storm.	X		X	X				

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
050 07 04 02		***Origin and local names, location and period of occurrence***								
(01)		List the areas of origin and occurrence of tropical revolving storms, and their specified names (hurricane, typhoon, tropical cyclone).	X		X	X				
(02)		State the expected times of occurrence of tropical revolving storms in each of the source areas, and their approximate frequency.	X		X	X				
050 08 00 00		**CLIMATOLOGY**								
050 08 01 00		**Climatic zones**								
050 08 01 01		***General circulation in the troposphere and lower stratosphere***								
(01)	X	Describe the general tropospheric and low stratospheric circulation. *(Refer to 050 02 03 01)*	X		X	X				
050 08 01 02		***Climatic classification***								
~~LO (01)~~		~~Name the world climate groups according to Koeppen's classification.~~	~~X~~		~~X~~	~~X~~				Not necessary to know
(02)	X	Describe the characteristics of the tropical rain climate, the dry climate, the mid-latitude climate (warm temperate rain climate), the subarctic climate (cold snow	X		X	X				

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		forest climate) and the snow climate (polar climate).								
(03)	X	Explain how the seasonal movement of the sun generates the transitional climate zones.	X		X	X				
~~LO (04)~~		~~Describe the typical weather in the tropical transitional climate (savannah climate) and in the temperate transitional climate (Mediterranean climate).~~	~~X~~		~~X~~	~~X~~				Included in 050 08 01 02 (03)
~~LO (05)~~		~~State the typical locations of each major climatic zone.~~	~~X~~		~~X~~	~~X~~				Not necessary to know
050 08 02 00		**Tropical climatology**								
050 08 02 01		***Cause and development of tropical showers and thunderstorms: humidity, temperature, tropopause***								
(01)		State the conditions necessary for the formation of tropical rain showers and thunderstorms (mesoscale convective complex, cloud clusters).	X		X	X				
(02)		Describe the characteristics of tropical squall lines.	X		X	X				
(03)		Explain the formation of convective cloud structures caused by convergence at the boundary of the NE and SE trade winds (Intertropical Convergence Zone (ITCZ)).	X		X	X				
(04)	X	State the typical figures for tropical surface air temperatures and humidities, and heights of the zero-degree isotherm.	X		X	X				

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
050 08 02 02		***Seasonal variations of weather and wind, typical synoptic situations***								
~~LO (01)~~		~~Describe the seasonal variations of weather and winds, and describe the typical synoptic situations.~~	~~X~~		~~X~~	~~X~~				Unclear Covered in LOs 050 08 02 02 (02) to (05)
(02)		Indicate on a map the trade winds (tropical easterlies) and describe the associated weather.	X		X	X				
(03)		Indicate on a map the doldrums and describe the associated weather.	X		X	X				
(04)		Indicate on a sketch the latitudes of subtropical high (horse latitudes) and describe the associated weather.	X		X	X				
(05)		Indicate on a map the major monsoon winds. ~~*(Refer to 050 08 02 04 for a description of the weather)*~~	X		X	X				Reference LO was deleted
050 08 02 03		***Intertropical Convergence Zone (ITCZ), weather in the ITCZ, general seasonal movement***								
(01)		Identify or indicate on a map the positions of the ITCZ in January and July.	X		X	X				
(02)	X	Explain the seasonal movement of the ITCZ.	X		X	X				
(03)		Describe the weather and winds at the ITCZ.	X		X	X				
~~LO (04)~~		~~Explain the variations in weather that are found at the~~	~~X~~		~~X~~	~~X~~				Duplicate

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		~~ITCZ.~~								
(05)		Explain the flight hazards associated with the ITCZ.	X		X	X				
050 08 02 04		***Monsoon, sandstorms, cold-air outbreaks***								
(01)		Define in general the term 'monsoon' and give a general overview of regions of occurrence.	X		X	X				Includes LO 050 08 02 04 (04) to (06)
~~LO (02)~~		~~Describe the major monsoon conditions.~~ ~~*(Refer to 050 08 02 02)*~~	~~X~~		~~X~~	~~X~~				Not necessary to know
(03)	X	Explain how trade winds change character after a long track and become monsoon winds.	X		X	X				
(04) New		Explain the weather and the flight hazards associated with a monsoon.	X		X	X				Necessity to combine weather and flight hazards of monsoon in one LO
~~LO (05)~~		~~Explain the formation of the SW/NE monsoon over West Africa and describe the weather, stressing the seasonal differences.~~	~~X~~		~~X~~	~~X~~				Not necessary to know
~~LO (06)~~		~~Explain the formation of the SW/NE monsoon over India and describe the weather, stressing the seasonal differences.~~	~~X~~		~~X~~	~~X~~				Not necessary to know
~~LO (07)~~		~~Explain the formation of the monsoon over the Far East and northern Australia and describe the weather, stressing the seasonal differences.~~	~~X~~		~~X~~	~~X~~				Not necessary to know

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
~~LO (08)~~		~~Describe the formation and properties of sandstorms.~~	~~X~~		~~X~~	~~X~~				Not necessary to know
~~LO (09)~~		~~Indicate when and where outbreaks of cold polar air can enter subtropical weather systems.~~	~~X~~		~~X~~	~~X~~				Not necessary to know
~~LO (10)~~		~~Name well-known examples of polar-air outbreaks (Blizzard, Pampero).~~	~~X~~		~~X~~	~~X~~				Not necessary to know
050 08 02 05		***~~Easterly waves~~***								
~~LO (01)~~		~~Describe and explain the formation of easterly waves, the associated weather and the duration of the weather activity.~~	~~X~~		~~X~~	~~X~~				Not necessary to know (see 050 08 02 05 (03))
~~LO (02)~~		~~Describe and explain the global distribution of easterly waves.~~	~~X~~		~~X~~	~~X~~				Not necessary to know (see 050 08 02 05 03)
(03)	X	Explain the effect of easterly waves on tropical weather systems.	X		X	X				050 08 02 05 (01) and (02) are covered here
050 08 03 00		**Typical weather situations in the mid-latitudes**								
050 08 03 01		***Westerly situation (westerlies)***								
(01)	X	Identify on a weather chart the typical westerly situation with travelling polar front waves.	X	X	X	X	X	X	X	
~~LO (02)~~		~~Describe the typical weather in the region of the travelling polar front waves including the seasonal variations.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
~~LO (03)~~		~~State the differences between the northern and the~~	~~X~~		~~X~~	~~X~~				Not necessary to know

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		~~southern hemisphere (roaring forties).~~								
050 08 03 02		***High-pressure area***								
(01)	X	Describe the high-pressure zones with the associated weather.	X	X	X	X	X	X	X	
(02)	X	Identify on a weather chart the high-pressure regions.	X	X	X	X	X	X	X	
~~LO (03)~~	X	~~Describe the weather associated with wedges in the polar air.~~ ~~*(Refer to 050 07 02 01)*~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical value
050 08 03 03		***Flat-pressure pattern***								
(01)	X	Identify on a surface weather chart the typical flat-pressure pattern.	X	X	X	X	X	X	X	
(02)	X	Describe the weather associated with a flat-pressure pattern.	X	X	X	X	X	X	X	
050 08 03 04		~~***Cold-air pool (cold-air drop)***~~ ***Cold-air drop (cold-air pool)***								More common
(01)	X	Define 'cold-air drop'~~'cold-air pool'~~.	X	X	X	X	X	X		Paragraph title changed
(02)	X	Describe the formation of a cold-air drop~~pool.~~	X	X	X	X	X	X		
~~LO (03)~~		~~Describe the characteristics of a cold-air pool with regard to dimensions, duration of life, geographical position, seasons, movements, weather activities and dissipation.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(04)	X	Identify cold-air drops~~pool~~ on weather charts.	X	X	X	X	X	X		See paragraph title
(05)		Explain the problems and dangers of cold-air drops~~pool~~ for aviation.	X	X	X	X	X	X		See paragraph title
050 08 04 00		**Local winds and associated weather**								
050 08 04 01		***Foehn, Mistral, Bora~~, Scirocco, Ghibli and Khamsin~~***								
(01)		Describe the classic~~al~~ mechanism for the development of Foehn winds (including Chinook).	X	X	X	X	X	X		
(02)		Describe the weather associated with Foehn winds.	X	X	X	X	X	X		
(03)		Describe the formation of, the characteristics of, and the weather associated with ~~the~~ Mistral and ~~the~~ Bora. ~~, the Scirocco, the Ghibli and the Khamsin.~~	X	X	X	X	X	X		Only Mistral & Bora
050 08 04 02		***Harmattan***								
(01)		Describe the Harmattan wind and the associated visibility problems as an example for local winds affecting visibility.	X		X	X				To see the principle and not the names of a few local winds
050 09 00 00		**FLIGHT HAZARDS**								
050 09 01 00		**Icing**								
050 09 01 01		***Conditions for ice accretion***								
(01)		Summarise the general conditions under which ice accretion occurs on aircraft (temperatures of outside air;	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		temperature of the airframe; presence of supercooled water in clouds, fog, rain and drizzle; possibility of sublimation).								
(02)		Indicate the general weather conditions under which ice accretion in a Venturi carburettor occurs.	X	X	X	X	X	X	X	
(03)		Explain the general weather conditions under which ice accretion on airframe occurs.	X	X	X	X	X	X	X	
(04)		Explain the formation of supercooled water in clouds, rain and drizzle. *(Refer to 050 03 02 01)*	X	X	X	X	X	X	X	
(05)		Explain qualitatively the relationship between the air temperature and the amount of supercooled water.	X	X	X	X	X	X	X	
(06)		Explain qualitatively the relationship between the type of cloud and the size and number of the droplets in cumuliform and stratiform clouds.	X	X	X	X	X	X	X	
(07)		Indicate in which circumstances ice can form on an aircraft on the ground: air temperature, humidity, precipitation.	X	X	X	X	X	X	X	
(08)		Explain in which circumstances ice can form on an aircraft in flight: inside clouds, in precipitation, outside clouds and precipitation.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(09)		Describe the different factors influencing 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.).	X	X	X	X	X	X	X	
(10)		Explain the effects of topography on icing.	X	X	X	X	X	X	X	
(11)		Explain the higher concentration of water drops in stratiform orographic clouds.	X	X	X	X	X	X	X	
050 09 01 02		***Types of ice accretion***								
(01)	X	Define ‘clear ice’.	X	X	X	X	X	X	X	
(02)		Describe the conditions for the formation of clear ice.	X	X	X	X	X	X	X	
(03)		Explain the formation of the structure of clear ice with the release of latent heat during the freezing process.	X	X	X	X	X	X	X	
(04)		Describe the aspect of clear ice: appearance, weight, solidity.	X	X	X	X	X	X	X	
(05)	X	Define ‘rime ice’.	X	X	X	X	X	X	X	
(06)		Describe the conditions for the formation of rime ice.	X	X	X	X	X	X	X	
(07)		Describe the aspects of rime ice: appearance, weight, solidity.	X	X	X	X	X	X	X	
(08)	X	Define ‘mixed ice’.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(09)		Describe the conditions for the formation of mixed ice.	X	X	X	X	X	X	X	
(10)		Describe the aspects of mixed ice: appearance, weight, solidity.	X	X	X	X	X	X	X	
(11)		Describe the possible process of ice formation in snow conditions.	X	X	X	X	X	X	X	
(12)	X	Define 'hoar frost'.	X	X	X	X	X	X	X	
(13)		Describe the conditions for the formation of hoar frost.	X	X	X	X	X	X	X	
(14)		Describe the aspects of hoar frost: appearance, solidity.	X	X	X	X	X	X	X	
050 09 01 03		***Hazards of ice accretion, avoidance***								
(01)		State the ICAO qualifying terms for the intensity of icing. *(See ICAO ATM Doc 4444)*	X	X	X	X	X	X	X	
(02)		Describe, in general, the hazards of icing.	X	X	X	X	X	X	X	
(03)		Assess the dangers of the different types of ice accretion.	X	X	X	X	X	X	X	
(04)		Describe the position of the dangerous zones of icing in fronts, in stratiform and cumuliform clouds, and in the different precipitation types.	X	X	X	X	X	X	X	
(05)		Indicate the possibilities of avoidance: — in the flight planning: weather briefing, choice of track and altitude;	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		— during flight: recognition of the dangerous zones, choice of appropriate track and altitude.								
050 09 01 04 (New)		**Ice crystal icing**								See justification in the Explanatory Note
(01) New		Describe ice crystal icing.	X	X	X	X	X	X	X	
(02) New		Describe the atmospheric processes leading to high ice crystal concentration. Define the variable ice water content (IWC).	X	X	X	X	X	X	X	
(03) New		Identify weather situations and their relevant areas where high concentrations of ice crystals are likely to occur.	X	X	X	X	X	X	X	
(04) New		Name, in general, the flight hazards associated with high concentrations of ice crystals.	X	X	X	X	X	X	X	
(05) New		Explain how the pilot can avoid areas with a high concentration of ice crystals.	X	X	X	X	X	X	X	
050 09 02 00		**Turbulence**								
050 09 02 01		***Effects on flight, avoidance***								
(01)		State the ICAO qualifying terms for the intensity of turbulence. *(See ICAO ATM Doc 4444)*	X	X	X	X	X	X	X	
(02)		Describe the effects of turbulence on an aircraft in flight.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(03)		Indicate the possibilities of avoidance: — in the flight planning: weather briefing, choice of track and altitude; — during flight: choice of appropriate track and altitude.	X	X	X	X	X	X	X	
(04) New		Describe atmospheric turbulence and distinguish between turbulence, gustiness and wind shear.	X	X	X	X	X	X	X	These parameters are part of MET reports; students must be able to distinguish between them
050 09 02 02		***Clear Air t Turbulence (CAT): effects on flight, avoidance***								
(01)		Describe the effects on flight caused by CAT. *(Refer to 050 02 06 03)*	X		X	X				
(02)		Indicate the possibilities of avoidance: — in the flight planning: weather briefing, choice of track and altitude; — during flight: choice of appropriate track and altitude.	X		X	X				
050 09 03 00		**Wind shear**								
050 09 03 01		***Definition of wind shear***								
(01)	X	Define ‘wind shear’ (vertical and horizontal).	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(02)	X	Define 'low-level wind shear'.	X	X	X	X	X	X	X	
050 09 03 02		***Weather conditions for wind shear***								
(01)		Describe the conditions, where and how wind shear can form (e.g. thunderstorms, squall lines, fronts, inversions, land and sea breeze, friction layer, relief).	X	X	X	X	X	X	X	
050 09 03 03		***Effects on flight, avoidance***								
(01)		Describe the effects on flight caused by wind shear.	X	X	X	X	X	X	X	
(02)		Indicate the possibilities of avoidance: — in the flight planning; — during flight.	X	X	X	X	X	X	X	
050 09 04 00		**Thunderstorms**								
050 09 04 01		***Conditions for and process of development, forecast, location, type specification***								
(01)		Name the cloud types which indicate the development of thunderstorms.	X	X	X	X	X	X	X	
(02)		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).	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
050 09 04 02		***Structure of thunderstorms, life history***								
~~LO (01)~~		~~Describe and sketch the stages of the life history of a thunderstorm: initial, mature and dissipating stage.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of 050 09 04 01 (02)
(02)		Assess the average duration of thunderstorms and their different stages.	X	X	X	X	X	X	X	
(03)		Describe a supercell storm: initial, supercell, tornado and dissipating stage.	X	X	X	X	X	X	X	
(04)		Summarise the flight hazards associated with a fully developed thunderstorm.	X	X	X	X	X	X	X	
(05)		Indicate on a sketch the most dangerous zones in and around a single-cell and a multicellular thunderstorm.	X	X	X	X	X	X	X	Must be differentiated
050 09 04 03		***Electrical discharges***								
(01)		Describe the basic outline of the electric field in the atmosphere.	X	X	X	X	X	X	X	
(02)		~~Describe the electrical potential differences in and around a thunderstorm.~~ Describe types of lightning, i.e. ground stroke, intra-cloud lightning, cloud-to-cloud lightning, upward lightning.	X	X	X	X	X	X	X	More precise
(03)		Describe and asses the ‘St. Elmo’s fire’ weather phenomenon.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(04)		Describe the development of lightning discharges.	X	X	X	X	X	X	X	
(05)		Describe the effect of lightning strike on aircraft and flight execution.	X	X	X	X	X	X	X	
050 09 04 04		***Development and effects of downbursts***								
(01)	X	Define the term 'downburst'.	X	X	X	X	X	X	X	
(02)		Distinguish between macroburst and microburst.	X	X	X	X	X	X	X	
(03)		State the weather situations leading to the formation of downbursts.	X	X	X	X	X	X	X	
(04)		Describe the process of development of a downburst.	X	X	X	X	X	X	X	
(05)		Give the typical duration of a downburst.	X	X	X	X	X	X	X	
(06)		Describe the effects of downbursts.	X	X	X	X	X	X	X	
050 09 04 05		***Thunderstorm avoidance***								
(01)		Explain how the pilot can anticipate each type of thunderstorms: pre-flight weather briefing, observation in flight, use of specific meteorological information, use of information given by ground weather radar and by airborne weather radar. *(Refer to 050 10 01 04)* ~~, use of the stormscope (lightning detector).~~	X	X	X	X	X	X	X	Storm scope outdated
(02)		Describe practical examples of flight techniques used to	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		avoid the hazards of thunderstorms.								
050 09 05 00		**Tornadoes**								
050 09 05 01		***Properties and occurrence***								
(01)	X	Define ~~the~~ 'tornado'.	X	X	X	X	X	X	X	
(02)		Describe the formation of a tornado.	X		X	X				
(03)		Describe the typical features of a tornado such as appearance, season, time of day, stage of development, speed of movement and wind speed (including the Fujita scale).	X		X	X				
~~LO (04)~~		~~Compare the occurrence of tornadoes in Europe with the occurrence in other locations, especially in the United States of America.~~	~~X~~		~~X~~	~~X~~				Not necessary to know
(05)		Compare the dimensions and properties of tornadoes and dust devils.	X		X	X				
050 09 06 00		**Inversions**								
050 09 06 01		***Influence on aircraft performance***								
~~LO (01)~~		~~Explain the influence of inversions on the aircraft performance.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Moved to 032
(02)		Compare the flight hazards during take-off and approach associated with a strong inversion alone and with a strong	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		inversion combined with marked wind shear.								
~~**050 09 07 00**~~		~~**Stratospheric conditions**~~								
~~***050 09 07 01***~~		~~***Influence on aircraft performance***~~								
~~LO (01)~~		~~Summarise the advantages of stratospheric flights.~~	~~X~~		~~X~~	~~X~~				No practical use
~~LO (02)~~		~~List the influences of the phenomena associated with the lower stratosphere (wind, temperature, air density, turbulence).~~	~~X~~		~~X~~	~~X~~				No practical use
050 09 08 00		**Hazards in mountainous areas**								
050 09 08 01		***Influence of terrain on clouds and precipitation, frontal passage***								
(01)		Describe the influence of a mountainous terrain on cloud and precipitation.	X	X	X	X	X	X	X	
~~LO (02)~~		~~Describe the effects of the Foehn.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of 050 08 04 01 (02)
(03)		Describe the influence of a mountainous area on a frontal passage.	X	X	X	X	X	X	X	
050 09 08 02		***Vertical movements, mountain waves, wind shear, turbulence, ice accretion***								
(01)		Describe the vertical movements, wind shear and turbulence typical of mountain areas.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(02)		Indicate ~~o~~in a sketch of a chain of mountains the turbulent zones (mountain waves, rotors).	X	X	X	X	X	X	X	
(03)		Explain the influence of relief on ice accretion.	X	X	X	X	X	X	X	
050 09 08 03		***Development and effect of valley inversions***								
~~LO (01)~~		~~Describe the formation of valley inversion due to katabatic winds.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
~~LO (02)~~		~~Describe the valley inversion formed by warm winds aloft.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not necessary to know
(03)		Describe the effects of a valley inversion for an aircraft in flight.	X	X	X	X	X	X	X	
050 09 09 00		**Visibility-reducing phenomena**								
050 09 09 01		***Reduction of visibility caused by precipitation and obscurations***								
(01)		Describe the reduction of visibility caused by precipitation: drizzle, rain, snow.	X	X	X	X	X	X	X	
(02)		Describe the reduction of visibility caused by obscurations: — fog, mist, haze, smoke, volcanic ash.	X	X	X	X	X	X	X	
(03)		Describe the reduction of visibility caused by obscurations: — sand (SA), dust (DU).	X		X	X				

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(04)		Describe the differences between ground ~~visibility~~ and flight visibility, slant ~~visibility~~ and vertical visibility when an aircraft is above or within a layer of haze or fog.	X	X	X	X	X	X	X	Better understanding
050 09 09 02		***Reduction of visibility caused by other phenomena***								
(01)	—	— Describe the reduction of visibility caused by low drifting and blowing snow.	X	X	X	X	X	X	X	
(02)	—	— Describe the reduction of visibility caused by low drifting and blowing dust and sand.	X		X	X				
(03)	—	— Describe the reduction of visibility caused by dust storm (DS) and sandstorm (SS).	X		X	X				
(04)	—	— Describe the reduction of visibility caused by icing (windshield).	X	X	X	X	X	X	X	
(05)	—	— Describe the reduction of visibility caused by the position of the sun relative to the visual direction.	X	X	X	X	X	X	X	
(06)	—	— Describe the reduction of visibility caused by the reflection of sun's rays from the top of the layers of haze, fog and clouds.	X	X	X	X	X	X	X	
050 10 00 00		**METEOROLOGICAL INFORMATION**								
050 10 01 00		**Observation**								
050 10 01 01		***Surface observations***								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
~~LO (01)~~		~~Define 'surface wind'.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Duplication of 050 02 01 01 (02)
~~LO (02)~~		~~Describe the meteorological measurement of surface wind.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Duplication of 050 02 01 01 (03)
~~LO (03)~~		~~List the ICAO units for the wind direction and speed used in METARs (kt, m/s, km/h).~~ ~~*(Refer to 050 02 01 01)*~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Duplication of 050 02 01 01 (02)
(04)		Define 'gusts', as given in METARs.	X	X	X	X	X	X		
(05)		Distinguish wind given in METARs and wind given by the control tower for take-off and landing.	X	X	X	X	X	X		
(06)		Define 'visibility'.	X	X	X	X	X	X	X	
(07)		Describe the meteorological measurement of visibility.	X	X	X	X	X	X	X	
(08)		Define 'prevailing visibility'.	X	X	X	X	X	X	X	
(09)		Define 'ground visibility'.	X	X	X	X	X	X	X	
(10)		List the units used for visibility (m, km, stat. mi.).	X	X	X	X	X	X	X	Regularly used unit
(11)		Define 'runway visual range'.	X	X	X	X	X	X	X	
(12)		Describe the meteorological measurement of runway visual range.	X	X	X	X	X	X	X	
(13)		Indicate where the transmissometers/forward-scatter	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		meters are placed on the airport.								
(14)		List the units used for runway visual range (m, ft).	X	X	X	X	X	X	X	Regularly used unit
(15)		List the different possibilities to transmit information to pilots about runway visual range.	X	X	X	X	X	X	X	
(16)		Compare ground visibility and runway visual range.	X	X	X	X	X	X	X	Must be differentiated
(17)		Indicate the means of observation of present weather.	X	X	X	X	X	X		
(18)		Indicate the means of observing clouds: type, amount, height of base (ceilometers) and top.	X	X	X	X	X	X		
(19)		~~List the clouds considered in meteorological reports, and how they are indicated in METARs, TAFs and SIGMETs (TCU, CB).~~ State the clouds which are indicated in METAR and TAF.	X	X	X	X	X	X	X	Clarity
(20)		Define ‘oktas’.	X	X	X	X	X	X	X	
(21)		Define ‘cloud base’.	X	X	X	X	X	X	X	
(22)		Define ‘ceiling’.	X	X	X	X	X	X	X	
(23)		Name the unit and the reference level used for information about cloud base (ft).	X	X	X	X	X	X	X	
(24)		Define ‘vertical visibility’.	X	X	X	X	X	X	X	
(25)		Explain briefly how and when vertical visibility is measured.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(26)		Name the unit used for vertical visibility (ft).	X	X	X	X	X	X	X	
(27)		Indicate the means of observation of air temperature (thermometer).	X	X	X	X	X	X		
~~LO (28)~~		~~List the units used for air temperature (Celsius, Fahrenheit, Kelvin).~~ ~~*(Refer to 050 01 02 01)*~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Duplication of 050 02 02 01 (02)
~~LO (29)~~		~~Indicate the means of observation of relative humidity (hygrometer and psychrometer) and dew-point temperature (calculation).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know
(30)		Name the units of relative humidity (%) and dew-point temperature (Celsius, Fahrenheit).	X	X	X	X	X	X		
~~LO (31)~~		~~Indicate the means of observation of atmospheric pressure (mercury and aneroid barometer).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know
~~LO (32)~~		~~List the units of atmospheric pressure (hPa, inches of Mercury).~~ ~~*(Refer to 050 01 03 01)*~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Duplication of 050 01 03 01 (02)
050 10 01 02		***Radiosonde observations***								
(01)	X	Describe the principle of radiosondes.	X	X	X	X	X	X		
~~LO (02)~~		~~Describe and interpret the sounding by radiosonde given on a simplified T-P diagram.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
050 10 01 03		***Satellite observations***								
(01)	X	Describe the basic outlines of satellite observations.	X	X	X	X	X	X		
(02)		Name the main uses of satellite pictures in aviation meteorology.	X	X	X	X	X	X		
(03)		Describe the different types of satellite imagery.	X	X	X	X	X	X		
(04)	—	Interpret qualitatively the satellite pictures in order to get useful information for the flights: — location of clouds (distinguish between stratiform and cumuliform clouds).	X	X	X	X	X	X		
(05)	—	— Interpret qualitatively the satellite pictures in order to get useful information for the flights: — location of fronts.	X	X	X	X	X	X		
(06)	—	— Interpret qualitatively the satellite pictures in order to get useful information for the flights: — location of jet streams.	X		X	X				
050 10 01 04		***Weather-radar observations*** ***(Refer to 050 09 04 05)***								
(01)		Describe the basic principle and the type of information given by a ground weather radar.	X	X	X	X	X	X		
(02)		Interpret ground weather radar images.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
(03)		Describe the basic principle and the type of information given by airborne weather radar.	X	X	X	X	X	X	X	
(04)		Describe the limits and the errors of airborne weather radar information.	X	X	X	X	X	X	X	
(05)		Name, for areas of differing reflection intensity, the colour gradations (green, yellow, red, magenta) indicating the increasing intensity of precipitation. *Remark: Airborne weather radar devices may use magenta for turbulence (not CAT).*	X	X	X	X	X	X	X	Moved from 062 03 03 02 (02)
(06)		Interpret typical airborne weather radar images.	X	X	X	X	X	X	X	
(07)		Describe the use of the weather radar to avoid a thunderstorm.	X	X	X	X	X	X	X	Moved from 062 03 03 06 (02)
(08)		Explain how turbulence (not CAT) can be detected by modern weather radar.	X	X	X	X	X	X	X	Moved from 062 03 03 06 (03)
(09)		Explain how wind shear can be detected by a modern weather radar.	X	X	X	X	X	X	X	Moved from 062 03 03 06 (04)
050 10 01 05		***Aircraft observations and reporting***								
(01)		Describe routine air-report and special air-report (ARS).	X	X	X	X	X	X		
(02)		State the obligation of a pilot to prepare air-reports.	X	X	X	X	X	X		
(03)		Name the weather phenomena to be stated in an	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		ARS~~special air report~~.								
050 10 02 00		**Weather charts**								
050 10 02 01		***Significant weather charts***								
(01)		Decode and interpret significant weather charts (low, medium and high level).	X	X	X	X	X	X	X	
(02)		Describe from a significant weather chart the flight conditions at designated locations and/or along a defined flight route at a given ~~flight level~~FL.	X	X	X	X	X	X	X	
050 10 02 02		***Surface charts***								
(01)		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.	X	X	X	X	X	X	X	Not necessary to know (see 050 01 03 01 05)
(02)		Determine from surface weather charts the wind direction and speed.	X	X	X	X	X	X		
050 10 02 03		***Upper-air charts***								
~~LO (01)~~		~~Define 'constant-pressure chart'.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not used by pilots
~~LO (02)~~		~~Define 'isohypse (contour line)'.~~ ~~*(Refer to 050 01 03 02)*~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not used by pilots
~~LO (03)~~		~~Define 'isotherm'.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not used in briefing

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
										material
~~LO (04)~~		~~Define 'isotach'~~.	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not used in briefing material
(05)		Describe forecast upper-wind and temperature charts.	X	X	X	X	X	X		
(06)		For designated locations and/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.	X	X	X	X	X	X		
~~LO (07)~~		~~Name the most common flight levels corresponding to the constant pressure charts.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not necessary to know
050 10 03 00		**Information for flight planning**								
050 10 03 01		***Aviation weather messages***								
(01)		Describe, decode and interpret the following aviation weather messages (given in written and/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	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		(GAMET), ~~special air report~~ARS, volcanic ash advisory information.								
(02)		Describe, decode and interpret the tropical cyclone advisory information in written and graphical form.	X		X	X				
(03)		Describe the general meaning of MET REPORT and SPECIAL REPORT.	X	X	X	X	X	X	X	
(04)		List, in general, the cases when a SIGMET and an AIRMET are issued.	X	X	X	X	X	X	X	
(05)		Describe, decode (by using a code table) and interpret the following messages: r~~R~~unway s~~S~~tate m~~M~~essage (as written in a METAR)~~, GAFOR~~. *Remark: For r~~R~~unway s~~S~~tate m~~M~~essage ~~and GAFOR,~~ refer to the Air Navigation Plan European Region Doc 7754.*	X	X	X	X	X	X	X	GAFOR not necessary to know
050 10 03 02		***Meteorological broadcasts for aviation***								
(01)		Describe the meteorological content of broadcasts for aviation: — meteorological information for aircraft in flight (VOLMET), automatic terminal information service (ATIS).	X	X	X	X	X	X	X	
(02)		Describe the meteorological content of broadcasts for aviation:	X		X	X				

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		— HF-VOLMET.								
050 10 03 03		***Use of meteorological documents***								
(01)		Describe meteorological briefing and advice.	X	X	X	X	X	X	X	
(02)		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.	X	X	X	X	X	X	X	
(03)		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.	X	X	X	X	X	X	X	
050 10 03 04		***Meteorological warnings***								
(01)		Describe and interpret aerodrome warnings and wind-shear warnings and alerts.	X	X	X	X	X	X	X	
050 10 04 00		**Meteorological services**								
050 10 04 01		***World area forecast system and meteorological offices***								
(01)	—	— Name the main objectives of the world area forecast system: — world area forecast centres (upper-air forecasts).	X	X	X	X	X	X		
(02)	—	— Name the main objectives of the world area	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		forecast system: — meteorological offices (aerodrome forecasts, briefing documents).								
(03)	—	— Name the main objectives of the world area forecast system: — meteorological watch offices (SIGMET, AIRMET).	X	X	X	X	X	X		
(04)	—	— Name the main objectives of the world area forecast system: — aeronautical meteorological stations (METAR, MET reports).	X	X	X	X	X	X		
(05)	—	— Name the main objectives of the world area forecast system: — volcanic ash advisory centres (VAACs).	X	X	X	X	X	X		
(06)	—	— Name the main objectives of the world area forecast system: — tropical cyclone advisory centres (TCACs).	X		X	X				
050 10 04 02		***International organisations***								
(01)		Describe briefly the following organisations and their chief activities in relation to weather for aviation: — International Civil Aviation Organization (ICAO) *(Refer to Ssubject 010)*;	X	X	X	X	X	X		More precise

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL			
		— World Meteorological Organization (WMO).								

Overview of the proposed amendments to Subject 061 'General navigation'

Learning Objectives (LOs) rearrangement

In order to facilitate the necessary improvements to the 061 LOs, the LOs have been rewritten in a new 061 document. The location of the revised LOs within the new 061 document is indicated in the 'Comments' column of the current NPA 2016-03(D).

For example:

061 04 02 06		***Airspeed***							**Comments**
(01)		Calculation of airspeed problems including IAS/EAS/CAS/TAS/ and Mach number from given appropriate data.	X	X	X	X	X		Moved to 061 01 05 01 (01) and 061 01 05 02 (01)

The 061 01 05 01 (01) and 061 01 05 02 (01) LOs in the new 061 document are:

061 01 05 01		***True airspeed (TAS)***							
(01)		Calculate TAS from calibrated speed (CAS) and CAS from TAS by: — mechanical computer; and — rule of thumb (2 % per 1 000 ft).	X	X	X	X	X		
061 01 05 02		***Mach number (M)***							
(01)		Calculate TAS from M and M from TAS.	X	X					

The reason for the new 061 document is to produce a much clearer document for national aviation authorities, the European Central Question Bank (ECQB) and approved training organisations (ATOs). The 297 existing LOs have been rearranged mainly in order to eliminate duplication and facilitate the transfer of LOs from 061 to other subjects. The extent of this revision is shown below:

— number of LOs identified as 'being of no practical use or invalid' = 44;

— number of LOs identified as 'belonging to other subject areas' (mainly 022, 033 and 050) = 48;

— number of LOs retained = 205;

— the number of LOs after rearrangement into the new 061 document is 76; this number includes the objectives that were previously contained in 205 separate LOs.

Mental dead reckoning (MDR) and visual flight rules (VFR) navigation

The necessity for a pilot to be able to perform mental calculations has been highlighted as potential safety issue by the training needs analysis (TNA). There is, therefore, a section within the new 061 document, which clarifies the requirement that will be tested in the licensing examinations. In addition, specific VFR navigation techniques have been described and again these techniques will be examined. There will be no mandate for ATOs to teach these techniques solely, and other techniques may be instructed and applied. However, it should be noted that the techniques described will be the basis for licensing examination questions.

Inertial navigation

In order to make Subject 022 more manageable and suitable for examination purposes, the LOs from inertial systems have been moved to Subject 061. The LOs are listed under the reference 061 06 in the new 061 document.

The new 061 document is placed after the following table.

SUBJECT 061 — GENERAL NAVIGATION

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
060 00 00 00		**NAVIGATION**							
061 00 00 00		**GENERAL NAVIGATION**							
061 01 00 00		**BASICS OF NAVIGATION**							
061 01 01 00		**The solar system**							
061 01 01 01		***Earth's orbit, seasons and apparent movement of the sun***							
~~LO (01)~~		~~State that the solar system consists of the Sun, a number of planets of which the Earth is one, and a large number of asteroids and comets.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (02)~~		~~State that Kepler's first law explains that the planets revolve in elliptical orbits with the Sun at one focus. Each planet has its orbital period.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (03)~~		~~State that Kepler's second law explains the variation in the speed of a planet in its orbit. Each planet revolves so that its radius vector sweeps out equal areas in equal intervals of time.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (04)~~		~~State that the highest speed of the Earth in its orbit is when the Earth is closest to the Sun (perihelion).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (05)~~		~~State that the lowest speed of the Earth in its orbit is when the Earth is furthest away from the Sun (aphelion).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(06)		Explain in which direction the Earth rotates on its axis.	X	X	X	X	X		Moved to 061 01 01 02 (01)
(07)		Explain that the axis of rotation of the Earth is inclined to its orbital path around the Sun at an angle of about 66,5 degrees.	X	X	X	X	X		Moved to 061 01 01 02 (01)
(08)		Define the term 'ecliptic' and 'plane of the ecliptic'. Ecliptic is the apparent path of the Sun around the Earth. The plane of the ecliptic is inclined to the plane of the equator at an angle of approximately 23,5 degrees. The inclination of the polar axis to the plane of the ecliptic is the reason for the seasons.	X	X	X	X	X		Moved to 061 01 01 02 (01) and (02)
(09)		Explain that the Earth completes one orbit around the Sun in approximately 365,25 days.	X	X	X	X	X		Moved to 061 01 01 02 (01)
(10)		Describe the effect of the inclination of the Earth's rotation axis to the plane of its orbit around the Sun, being the seasons and variation of sunrise and sunset with latitude and time of the year.	X	X	X	X	X		Moved to 061 01 01 02 (02)
(11)		Define the terms 'apparent Sun' and 'mean Sun' and state their relationship.	X	X	X	X	X		Moved to 061 05 01 01 (01)
(12)		Define the 'celestial equator'. It is the projection of the Earth's equator onto the celestial sphere.	X	X	X	X	X		Moved to 061 05 01 01 (01)
(13)		Define the term 'declination'. Declination is the angular distance of a celestial body north or south of the celestial equator.	X	X	X	X	X		Moved to 061 05 01 01 (01)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(14)		State that the mean Sun is conceived to move eastward along the celestial equator at a rate that provides a uniform measure of time equal to the average time reckoned from the true Sun.	X	X	X	X	X		Moved to 061 05 01 01 (01)
(15)		Define the 'polar circles', the 'tropic of Cancer' and the 'tropic of Capricorn'.	X	X	X	X	X		Moved to 061 05 03 01 (02)
(16)		Explain summer and winter solstice.	X	X	X	X	X		Moved to 061 05 03 01 (02)
(17)		Explain the terms 'spring and autumn equinox'.	X	X	X	X	X		Moved to 061 05 03 01 (02)
~~LO (18)~~		~~Explain at which time of the year the duration of daylight changes at the highest rate.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(19)		Explain the relationship between the declination of the Sun, latitude and the period of daylight.	X	X	X	X	X		Moved to 061 05 03 01 (02)
~~LO (20)~~		~~State that the perihelion occurs early January and aphelion occurs early July.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(21)		Illustrate the position of the Earth relative to the Sun with respect to the seasons and months of the year.	X	X	X	X	X		Moved to 061 05 03 01 (02)
~~LO (22)~~		~~Define 'zenith'. The point on the sky vertically overhead an observer.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
061 01 02 00		**The Earth**							
061 01 02 01		***Great circle, small circle, rhumb line***							

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(01)		State that the Earth is not a true sphere. It is flattened slightly at the poles. The value for flattening is 1/298.	X	X	X	X	X		Moved to 061 01 01 01 (01) and (02)
~~LO (02)~~		~~Given the Earth flattening and either the semimajor or semiminor axis in NM/km, calculate the distance of the other axis.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(03)		State that the Earth may be described as an 'ellipsoid' or 'oblate spheroid'.	X	X	X	X	X		Moved to 061 01 01 01 (02)
(04)		Explain that the Equator has its plane perpendicular to the Earth's axis and divides the Earth into the northern and southern hemisphere.	X	X	X	X	X		Moved to 061 01 01 02 (01) and 061 01 02 01 (02)
~~LO (05)~~		~~Given that the distance of the circumference of the Earth is 40 000 km or approximately 21 600 NM, calculate the approximate Earth diameter or Earth radius.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(06)		Define a 'great circle' in relation to the surface of a sphere.	X	X	X	X	X		Moved to 061 03 01 01 (01)
(07)		Describe the 'geometric properties' of a great circle, including vertex.	X	X	X	X	X		Moved to 061 03 01 01 (01)
(08)		Define a 'small circle' in relation to the surface of a sphere.	X	X	X	X	X		Moved to 061 03 01 01 (01)
(09)		Define a 'rhumb line'. A line which cuts all meridians at the same angle.	X	X	X	X	X		Moved to 061 03 02 01 (01)
061 01 02 02		***Convergency, conversion angle***							

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(01)		Explain the term 'convergency of meridians' between two positions.	X	X	X	X	X		Moved to 061 03 01 02 (01)
(02)		Explain how the value of convergency can be determined using calculation.	X	X	X	X	X		Moved to 061 03 01 02 (02)
(03)		The formula to calculate convergency between two positions relatively close to each other is: convergency = difference of longitude × sin (mean latitude).	X	X	X	X	X		Moved to 061 03 01 02 (02)
(04)		Calculate the value of convergency between two stated positions.	X	X	X	X	X		Moved to 061 03 01 02 (03)
(05)		Explain that the difference between great-circle track and rhumb-line track at a specified position is called conversion angle.	X	X	X	X	X		Moved to 061 03 03 02 (01)
(06)		State that over short distances and out-of-polar regions the average great-circle true track is approximately equal to the rhumb-line true track between two positions.	X	X	X	X	X		Moved to 061 03 03 02 (01)
(07)		Explain how the value of conversion angle can be calculated as half the value of convergency.	X	X	X	X	X		Moved to 061 03 03 02 (01)
(08)		Calculate the great-circle track and rhumb-line track angle at specified position involving calculations of convergency and conversion angle.	X	X	X	X	X		Moved to 061 03 03 02 (01)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
061 01 02 03		***Latitude, difference of latitude***							
(01)		Define 'geographic latitude' as the angle between the plane of the equator and the local plumb line on the ellipsoid.	X	X	X	X	X		Moved to 061 01 02 01 (02)
~~LO (02)~~		~~Define 'geocentric latitude' as the angle between the plane of the equator and a line from the position to the centre of the Earth.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (03)~~		~~State that the maximum difference between geographic and geocentric latitude occurs at altitude of 45 degrees.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use (and spelling mistake)
(04)		Describe a parallel of latitude as a small circle connecting all positions on the Earth with the same latitude.	X	X	X	X	X		Moved to 061 01 02 01 (02)
(05)		Calculate the difference of latitude between two given positions lat/long.	X	X	X	X	X		Moved to 061 01 02 01 (03)
(06)		State that the 1-degree difference of latitude equals 60 nautical miles.	X	X	X	X	X		Moved to 061 01 04 01 (01) and (02)
(07)		Convert the difference of latitude to distance.	X	X	X	X	X		Moved to 061 01 04 03 (01)
~~LO (08)~~		~~Calculate the mean latitude between two positions.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Basic arithmetic
061 01 02 04		***Longitude, difference of longitude***							
(01)		Describe a meridian as a semigreat circle, which runs north and south from pole to pole.	X	X	X	X	X		Moved to 061 01 02 01 (04)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(02)		Explain that the meridians and their anti-meridian complete a great circle.	X	X	X	X	X		Moved to 061 01 02 01 (04)
(03)		State that the Greenwich meridian is also known as the prime meridian.	X	X	X	X	X		Moved to 061 01 02 01 (04)
(04)		Define 'longitude' as the angle measured at the polar axis between the plane of the prime meridian and the local meridian.	X	X	X	X	X		Moved to 061 01 02 01 (04)
(05)		Explain that the Greenwich anti-meridian is the maximum longitude possible, namely 180° east–west.	X	X	X	X	X		Moved to 061 01 02 01 (04)
(06)		Calculate the difference of longitude between two given positions lat/long.	X	X	X	X	X		Moved to 061 01 02 01 (05)
~~LO (07)~~		~~Name examples of great circles on the surface of the Earth.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (08)~~		~~Name examples of small circles on the surface of the Earth.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(09)		Define a 'rhumb line'. A line intersecting all meridians at the same angle.	X	X	X	X	X		Moved to 061 03 02 01 (01) and (03)
(10)		Explain the geometrical properties of a rhumb line. Parallels and meridians are special cases of rhumb lines.	X	X	X	X	X		Moved to 061 03 02 01 (01) and (02)
061 01 02 05		***Use of latitude and longitude coordinates to locate any specific position***							
(01)		Explain that along the equator a difference of longitude of 1°	X	X	X	X	X		Moved to 061 01 04 01 (02)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		equals a distance of 60 NM.							
(02)		Explain that because the meridians converge towards the poles, the distance between meridians will decrease with increase in latitude.	X	X	X	X	X		Moved to 061 01 04 03 (01)
~~LO (03)~~		~~State that the Earth's distance along a parallel of latitude is also known as departure.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(04)		Calculate the Earth's distance between two meridians along a parallel of latitude (departure) using the following formula: distance = difference of longitude × 60 × cosine latitude.	X	X	X	X	X		Moved to 061 01 04 03 (01)
(05)		Given a position lat/long, distances travelled north–south in NM/km and distance travelled east–west in NM/km along a parallel of latitude. Calculate the new position.	X	X	X	X	X		Moved to 061 01 04 03 (01)
(06)		Given two positions on same meridian (or one on the anti-meridian), calculate the distance.	X	X	X	X	X		Moved to 061 01 04 03 (01)
061 01 03 00		**Time and time conversions**							
061 01 03 01		***Apparent time***							
~~LO (01)~~		~~Explain the principles of zone time.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(02)		Explain that, because the Earth rotates on its axis from west to east, the celestial bodies appear to revolve around the Earth from east to west.	X	X	X	X	X		Moved to 061 05 01 01 (01)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
~~LO (03)~~		~~Define and explain the term 'transit'. Explain that transit means that a celestial body crosses the observer's meridian.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(04)		Explain that the time period of a 'day' is the elapsed time between two successive transits of a heavenly body.	X	X	X	X	X		Moved to 061 05 01 01 (01)
(05)		Explain that the term 'sidereal day' is the time measured with reference to a fixed point on the celestial sphere.	X	X	X	X	X		Moved to 061 05 01 01 (01)
(06)		State that if the day is measured by the apparent passage of the Sun, the length of a day will vary.	X	X	X	X	X		Moved to 061 05 01 01 (01)
(07)		Explain the reason for the variation in the length of an apparent day, being a combination of the variation in the Earth's orbital speed around the Sun and the inclination of the Earth's rotation axis to the plane of the ecliptic.	X	X	X	X	X		Moved to 061 05 01 01 (01)
(08)		Illustrate that, since both the direction of rotation of the Earth around its axis and its orbital rotation around the Sun are the same, the Earth must rotate through more than 360° to produce successive transits.	X	X	X	X	X		Moved to 061 05 01 01 (01)
(09)		State that the period between two successive transits of the Sun is called an apparent solar day, and that the time based on this is called apparent time.	X	X	X	X	X		Moved to 061 05 01 01 (01)
(10)		State that in order to have a constant measurement of time, which will still have the solar day as a basis, the average length	X	X	X	X	X		Moved to 061 05 01 01 (01)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		of an apparent solar day is taken. This average day is called mean solar day. It is divided into 24 hours of mean time.							
(11)		State that the mean Sun is a fictitious Sun orbiting along the plane of the equator at a constant angular velocity that provides a uniform measure of time.	X	X	X	X	X		Moved to 061 05 01 01 (01)
(12)		State that the time between two successive transits of the mean Sun over a meridian is constant.	X	X	X	X	X		Moved to 061 05 01 01 (01)
~~LO (13)~~		~~Explain that the difference between apparent time and mean time is defined as the 'equation of time'.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (14)~~		~~State that the time of orbital revolution of the Earth in 1 year around the Sun is approximately 365 ¼ calendar days.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Basic school knowledge
~~LO (15)~~		~~State that the calendar year is 365 days and every 4th year a leap year with 366 days and 3 leap years are suppressed every 4 centuries.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Basic school knowledge
(16)		State that time can also be measured in arc since, in one day of mean solar time, the mean Sun is imagined to travel in a complete circle round the Earth, a motion of 360° in 24 hours.	X	X	X	X	X		Moved to 061 05 01 01 (01)
(17)		Illustrate the relationship between time and arc along the equator.	X	X	X	X	X		Moved to 061 05 01 01 (01)
(18)		Deduce conversion values for arc to time and visa versa.	X	X	X	X	X		Moved to 061 05 01 02 (02)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
061 01 03 02		***Universal Time Coordinated (UTC)***							
(01)		State that the Greenwich meridian is selected as standard meridian, and that LMT at the Greenwich meridian is equal to Greenwich mean time (GMT).	X	X	X	X	X		Moved to 061 05 01 02 (02)
(02)		State that UTC is based on atomic time and GMT on the Earth's rotation, but in practice they are considered as the same.	X	X	X	X	X		Moved to 061 05 01 02 (01)
(03)		State that the conversion factor between LMT and UTC is arc (change of longitude) converted to time.	X	X	X	X	X		Moved to 061 05 01 02 (02)
(04)		Convert arc to time.	X	X	X	X	X		Moved to 061 05 01 02 (02)
(05)		Convert time to arc.	X	X	X	X	X		Moved to 061 05 01 02 (02)
(06)		Convert between UTC and LMT.	X	X	X	X	X		Moved to 061 05 01 02 (02)
061 01 03 03		***Local Mean Time (LMT)***							
(01)		State that the beginning of the local mean day at any location is when the mean Sun is in transit with the anti-meridian. This is known as midnight or 0000 hours LMT.	X	X	X	X	X		Moved to 061 05 01 01 (01)
(02)		State that when the mean Sun is in transit with the location's meridian, it is noon or 1200 hours LMT.	X	X	X	X	X		Moved to 061 05 01 01 (01)
(03)		State that the LMT at locations at different longitudes varies by an amount corresponding to the change in longitude.							Moved to 061 05 01 02 (02)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
061 01 03 04		***Standard times (STs)***							
(01)		State that standard time is the time used by a particular country (or part of a country) determined by the government of that particular country.	X	X	X	X	X		Moved to 061 05 02 01 (01)
(02)		State that some countries use summer time (daylight saving time).	X	X	X	X	X		Moved to 061 05 02 01 (01)
(03)		State that conversion from UTC to standard time and visa versa is usually done using extracts from the air almanac published in appropriate documents.	X	X	X	X	X		Moved to 061 05 02 01 (01)
(04)		Given appropriate documents, convert from UTC to ST of a specific country and from ST of a specific country to UTC.	X	X	X	X	X		Moved to 061 05 02 01 (01)
061 01 03 05		***Dateline***							
(01)		Explain the effect on the LMT when approaching the 180° meridian line from either side.	X	X	X	X	X		Moved to 061 05 02 02 (01)
(02)		State that the dateline does not follow exactly the 180° east–west meridian.	X	X	X	X	X		Moved to 061 05 02 02 (01)
(03)		Explain that when crossing the anti-meridian of Greenwich, one day is lost or gained depending on the direction of travel.	X	X	X	X	X		Moved to 061 05 02 02 (01)
(04)		State that the dateline is the actual place where the change is made and, although mainly at the 180° meridian, there are	X	X	X	X	X		Moved to 061 05 02 02 (01)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		some slight divergences in order to avoid countries being divided by the dateline.							
(05)		State that when calculating times, the dateline is automatically taken into account by doing all conversions via UTC.	X	X	X	X	X		Moved to 061 05 02 02 (01)
(06)		Calculate conversions of LMT and GMT/UTC and ST for cases involving the international dateline.	X	X	X	X	X		Moved to 061 05 02 02 (01)
061 01 03 06		***Determination of sunrise (SR), sunset (SS) and civil twilight***							
(01)		State that SR or SS is when the Sun's upper edge is at the observer's horizon. State how atmospheric refraction affects this apparent sighting.	X	X	X	X	X		Moved to 061 05 03 01 (01)
(02)		Explain that SR and SS occur at different times on the same meridian depending on the latitude for a given day.	X	X	X	X	X		Moved to 061 05 03 01 (02)
(03)		Explain that SR will occur earlier and SS will occur later with increase in altitude.	X	X	X	X	X		Moved to 061 05 03 01 (02)
(04)		State that the times for SR and SS given in the air almanac are calculated for the Greenwich meridian.	X	X	X	X	X		Moved to 061 05 03 01 (01)
(05)		Explain that at the spring and autumn equinox, SR and SS occur approximately at the same time at all latitudes.	X	X	X	X	X		Moved to 061 05 03 01 (02)
(06)		State that, except in high latitudes, the times of SR and SS at any place change only a little each day. So, for all places of the	X	X	X	X	X		Moved to 061 05 03 01 (02)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		same latitude, SR or SS will occur at approximately the same LMT.							
(07)		State that the reason for the variation of the duration of daylight and night throughout the year is the inclination of the Earth's rotation axis to the ecliptic.	X	X	X	X	X		Moved to 061 05 03 01 (02)
(08)		State that SR and SS times are tabulated against specified dates and latitudes.	X	X	X	X	X		Moved to 061 05 03 01 (01)
(09)		State that at equator SR is always close to 0600 LMT and SS close to 1800 LMT (within 15 minutes).	X	X	X	X	X		Moved to 061 05 03 01 (02)
(10)		Calculate examples of SR and SS at mean sea level in LMT, ST or UTC, given SR and SS tables, latitudes and longitude of the place in question and the date.	X	X	X	X	X		Moved to 061 05 03 01 (01)
(11)		Given SR or SS time in UTC or ST for a given position, calculate SR or SS for another position on the same latitude in UTC or ST.	X	X	X	X	X		Moved to 061 05 03 01 (01)
(12)		Explain the meaning of the term 'twilight'.	X	X	X	X	X		Moved to 061 05 03 01 (01)
(13)		Define the 'duration of evening civil twilight'. The time from sunset to the time when the centre of the Sun is 6° below the horizon.	X	X	X	X	X		Moved to 061 05 03 01 (01)
(14)		Define the 'duration of morning civil twilight'. The time from the point when the centre of the Sun is 6° below the horizon to the time of sunrise.	X	X	X	X	X		Moved to 061 05 03 01 (01)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(15)		State that the beginning of morning civil twilight and the end of evening civil twilight has been tabulated in UTC, valid for the prime meridian, with latitude and date as the entering argument. It may be taken to be LMT for any other meridian.	X	X	X	X	X		Moved to 061 05 03 01 (01)
(16)		Calculate examples of twilight in UTC and ST given a twilight table, latitude and longitude of the place in question and the date.	X	X	X	X	X		Moved to 061 05 03 01 (01)
(17)		Determine the duration of morning and evening civil twilight.	X	X	X	X	X		Moved to 061 05 03 01 (01)
(18)		Explain the effect of declination and latitude on the duration of twilight.	X	X	X	X	X		Moved to 061 05 03 01 (02)
061 01 04 00		**Directions**							
061 01 04 01		***True north***							
(01)		State that all meridians run in north–south direction, and that the true-north direction is along any meridian towards the geographic north pole.	X	X	X	X	X		Moved to 061 01 03 01 (01)
(02)		State that true directions are measured clockwise as an angle in degrees from true north.	X	X	X	X	X		Moved to 061 01 03 01 (02)
061 01 04 02		***Terrestrial magnetism: magnetic north, inclination and variation***							
~~LO (01)~~		~~State that a freely suspended compass needle will turn to the~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		~~direction of the local magnetic field. The direction of the horizontal component of this field is the direction of magnetic north (MN).~~							
(02)		State that the magnetic poles do not coincide with the geographic poles.	X	X	X	X	X		Moved to 061 01 03 01 (03)
(03)		State that the magnetic variation varies as a function of time due to the movement of the northern magnetic pole.	X	X	X	X	X		Moved to 061 01 03 01 (05)
~~LO (04)~~		~~Define 'magnetic dip or inclination'. The angle between the horizontal and the total component of the magnetic field.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
~~LO (05)~~		~~State that the angle of inclination at the magnetic poles is 90°.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
~~LO (06)~~		~~Explain that the accuracy of the compass depends on the strength of the horizontal component of the Earth's magnetic field.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
~~LO (07)~~		~~State that, in the polar areas, the horizontal component of the Earth's magnetic field is too weak to permit the use of a magnetic compass.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
061 01 04 03		***Compass deviation, compass north***							
~~LO (01)~~		~~State that, in a direct-reading compass, the magnetic element will align along a magnetic field. This direction is called compass north (CN) and is the direction 000° on the compass rose. The field is the resultant of the Earth's magnetic field and~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		~~the magnetic field of the aircraft.~~							
~~LO (02)~~		~~State that the effect of the aircraft magnetism on the compass changes with different headings, as well as with different latitudes.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
(03)		State that the angle between magnetic north and compass northis called deviation (DEV) and is given in degrees east (+ or E) or west (– or W) of the magnetic north.	X	X	X	X	X		Moved to 061 01 03 01 (07)
~~LO (04)~~		~~State that deviation is kept to a minimum by compass swinging.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
061 01 04 04		***Isogonals, relationship between true and magnetic north***							
(01)		State that the angle between the true north and magnetic northis called variation (VAR) being measured in degrees east (+ or E) or west (– or W) of the true north.	X	X	X	X	X		Moved to 061 01 03 01 (04)
(02)		Define an ‘isogonal line’. A line joining positions of equal variation.	X	X	X	X	X		Moved to 061 01 03 01 (04)
(03)		Convert between compass, magnetic and true directions.	X	X	X	X	X		Moved to 061 01 03 01 (04) and (07)
061 01 04 05		***Gridlines, isogrives***							
~~LO (01)~~		~~Explain the purpose of a grid north (GN) based on a suitable meridian on a polar stereographic chart (reference or datum meridian).~~	~~X~~		~~X~~	~~X~~			No practical use

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
~~LO (02)~~		~~Explain that the gridlines or the grid meridians are drawn on the chart parallel to the reference meridian.~~	~~X~~		~~X~~	~~X~~			No practical use
~~LO (03)~~		~~State that the angle between the grid north (GN) and true north (TN) is called grid convergence being measured in degrees east (+ or E) if GN is west of TN or west (– or W) if GN is east of TN.~~	~~X~~		~~X~~	~~X~~			No practical use
~~LO (04)~~		~~State that the angle between the grid north (GN) and magnetic north (MN) is called grivation (griv) being measured in degrees east (+ or E) or west (– or W) of the grid north.~~	~~X~~		~~X~~	~~X~~			No practical use
~~LO (05)~~		~~State that a line joining points, which have the same grivation, is called an isogriv.~~	~~X~~		~~X~~	~~X~~			No practical use
~~LO (06)~~		~~Convert between compass, magnetic, true and grid directions.~~	~~X~~		~~X~~	~~X~~			No practical use
061 01 05 00		**Distance**							
061 01 05 01		***Units of distance and height used in navigation: nautical miles, statute miles, kilometres, metres, feet***							
(01)		Define the 'nautical mile'. A distance being equal to 1 852 km.	X	X	X	X	X		Moved to 061 01 04 01 (01)
~~LO (02)~~		~~In map/charts, distance between two positions is measured along a meridian at mean latitude, where 1 minute of latitude presents 1 NM.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not an LO
~~LO (03)~~		~~State that when dealing with heights and altitudes the unit~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Not an LO for 061

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		~~used is metres or feet subject to the choice of individual States.~~							
061 01 05 02		***Conversion from one unit to another***							
(01)		Convert between the following units: nautical miles (NM), statute miles (SM), kilometres (km), metres (m) and feet (ft).	X	X	X	X	X		Moved to 061 01 04 02 (01)
061 01 05 03		***Relationship between nautical miles and minutes of latitude and minutes of longitude***							
(01)		State that horizontal distances are calculated in metres, kilometres and nautical miles.	X	X	X	X	X		Moved to 061 01 04 02 (01)
(02)		Given two positions or latitude/longitude difference, calculate the distance.	X	X	X	X	X		Moved to 061 01 04 03 (01)
(03)		Given two positions on the same latitude and distance between the two positions in km or NM, calculate the difference of longitude between the two positions.	X	X	X	X	X		Moved to 061 01 04 03 (01)
(04)		Flying a rhumb-line true track of 090, 180, 270 and 360 degrees given an initial geographical position, flight time and ground speed, calculate the new geographic position.	X	X	X	X	X		Moved to 061 01 04 03 (01)
061 02 00 00		**MAGNETISM AND COMPASSES**							
061 02 01 00		**Knowledge of the principles of the direct-reading (standby) compass**							
061 02 01 01		***The use of this compass***							

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
~~LO (01)~~		~~Direct-reading compass (DRC).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
~~LO (02)~~		~~Interpret the indications on a DRC, given an indication on the compass, deviation or deviation table and variation.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
061 02 01 02		***Serviceability tests***							
~~LO (01)~~		~~State the pre-flight serviceability check of the DRC, such as:~~ ~~— general condition;~~ ~~— check indication is within the limits.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
~~LO (02)~~		~~State that the serviceability test consists of comparing the DRC indication to another reference (e.g. other compass system or runway direction).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
~~LO (03)~~		~~State that the compass should be checked when carrying magnetic freight or freight with a large ferrous metal content.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
061 02 01 03		***Situations requiring a compass swing***							
~~LO (01)~~		~~State the occurrences when a compass swing may be required:~~ ~~— if transferred to another base involving a large change in latitude;~~ ~~— major changes in aircraft equipment;~~ ~~— aircraft hit by lightning;~~ ~~— aircraft parked in the same direction for a long period of time;~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		~~— when a new compass is fitted;~~ ~~— at any time when the compass or recorded deviation is suspect;~~ ~~— when specified in the aircraft maintenance schedule.~~							
061 03 00 00		**CHARTS**							
061 03 01 00		**General properties of miscellaneous types of projections**							
(01)		Define the term 'conformal'. At any given point on the chart, distortions (as a result of the projection) in east–west direction must be the same as in north–south direction. The meridians and parallels must cut each other at right angles.	X	X	X	X	X		Moved to 061 04 01 01 (01)
(02)		State that on a conformal chart the angles measured on the chart are the same as on the Earth.	X	X	X	X	X		Moved to 061 04 01 01 (01)
(03)		State that different chart projections are used, depending on the application and area of use involved.	X	X	X	X	X		Moved to 061 04 02 01 (01)
(04)		State that all charts, although they have been developed mathematically, are designated as projections.	X	X	X	X	X		Moved to 061 04 02 01 (01)
(05)		State that the following projection surfaces are used when projecting charts: — plane, — cylindrical,	X	X	X	X	X		Moved to 061 04 02 01 (01)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		— conical.							
(06)		Define the 'scale' of a chart. The ratio of the chart length compared to the Earth's distance that it represents.	X	X	X	X	X		Moved to 061 04 01 03 (01)
(07)		Use the scale of a chart to calculate particular distances.	X	X	X	X	X		Moved to 061 04 01 03 (02)
(08)		Calculate scale given chart length and Earth distance.	X	X	X	X	X		Moved to 061 04 01 03 (02)
(09)		Define the term 'chart convergency'. The angle between two given meridians on the chart.	X	X	X	X	X		Moved to 061 04 02 02 (01), 061 04 02 03 (01) and 061 04 02 04 (01)
(10)		Define 'parallel of origin'. The parallel where the projection surface touches the surface of the reduced Earth.	X	X	X	X	X		Moved to 061 04 02 02 (01), 061 04 02 03 (01) and 061 04 02 04 (01)
061 03 01 01		***Direct Mercator***							
(01)		State that the direct Mercator is a cylindrical projection. The parallel of origin is the equator.	X	X	X	X	X		Moved to 061 04 02 03 (01)
(02)		State that the convergency on the chart is 0°.	X	X	X	X	X		Moved to 061 04 02 03 (01)
(03)		State that the scale increases with increasing distance from the equator.	X	X	X	X	X		Moved to 061 04 02 03 (01)
~~LO (04)~~		~~State that on a direct Mercator: scale at any latitude = scale at the equator × secant latitude (1/cosine latitude).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
~~LO (05)~~		~~Given the scale at one latitude, calculate the scale at different latitudes.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (06)~~		~~Given a chart length at one atitude, show that it represents a different Earth distance at other latitudes.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
061 03 01 02		***Lambert conformal conic***							
(01)		State that the Lambert conformal chart is based on a conical projection. Only Lambert conformal charts mathematically produced with two standard parallels will be considered.	X	X	X	X	X		Moved to 061 04 02 04 (01)
(02)		Define the term 'standard parallel'. The latitudes where the cone cuts the reduced Earth.	X	X	X	X	X		Moved to 061 04 02 04 (01)
(03)		State that at the parallel of origin, Earth convergency is equal to chart convergency.	X	X	X	X	X		Moved to 061 04 02 04 (01)
(04)		State that the parallel of origin is close to the mean latitude between the standard parallels.	X	X	X	X	X		Moved to 061 04 02 04 (01)
~~LO (05)~~		~~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.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(06)		Define the term 'constant of cone/convergency factor'. The ratio between the top angle of the unfolded cone and 360°, or sine of the parallel of origin.	X	X	X	X	X		Moved to 061 04 02 04 (01)
(07)		Chart convergency = difference of longitude × constant of cone.	X	X	X	X	X		Moved to 061 04 02 04 (01)
~~LO (08)~~		~~Given appropriate data, calculate initial, final or rhumb line tracks between two positions (lat/long).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		A rhumb line is not plotted on the Lambert chart
~~LO (09)~~		~~Given two positions (lat/long) and information to determine convergency between the two positions, calculate the parallel of origin.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (10)~~		~~Given a Lambert chart, determine the parallel of origin, or constant of cone.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (11)~~		~~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.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
061 03 01 03		***Polar stereographic***							
(01)		State that the polar stereographic projection is based on a plane projection, and state that the parallel of the origin is the pole.	X		X	X			Moved to 061 04 02 02 (01)
(02)		State that chart convergency = difference of longitude.	X		X	X			Moved to 061 04 02 02 (01)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(03)		State that the scale is increasing with increasing distance from the pole.	X		X	X			Moved to 061 04 02 02 (01)
~~LO (04)~~		~~Given two positions (lat/long), rhumb-line true track or initial/final great-circle true track, calculate the missing track angles.~~	~~X~~		~~X~~	~~X~~			A rhumb line is not plotted on the polar steroegraphic chart
~~LO (05)~~		~~Calculate the chart scale at a specific latitude when difference of longitude and chart distance along the parallel of longitude are given.~~	~~X~~		~~X~~	~~X~~			No practical use
061 03 02 00		**The representation of meridians, parallels, great circles and rhumb lines**							
061 03 02 01		***Direct Mercator***							
(01)		State that meridians are straight parallel lines, which cut parallels of latitudes at right angles.	X	X	X	X	X		Moved to 061 04 02 03 (01)
(02)		State that parallels of latitude are straight lines parallel to the equator.	X	X	X	X	X		Moved to 061 04 02 03 (01)
(03)		State that a straight line on the chart is a rhumb line.	X	X	X	X	X		Moved to 061 04 02 03 (01)
(04)		State that the great circle is a line convex to the nearest pole.	X	X	X	X	X		Moved to 061 04 02 03 (01)
~~LO (05)~~		~~For great-circle track angle calculations over short distances, the conversion angle may be calculated by the formula:~~ ~~— conversion angle = ½ × difference of longitude × sin~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		A great circle is not plotted on the direct Mercator chart

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		~~mean latitude.~~							
~~LO (06)~~		~~Given rhumb line true track between two positions (lat/long), calculate initial or final great-circle true track.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		A great circle is not plotted on the direct Mercator chart
061 03 02 02		***Lambert conformal conic***							
(01)		State that meridians are straight lines, which cut parallels of latitudes at right angles.	X	X	X	X	X		Moved to 061 04 02 04 (01)
(02)		State that parallels of latitude are arcs of concentric circles.	X	X	X	X	X		Moved to 061 04 02 04 (01)
(03)		State that great circles are curved lines concave towards the parallels of origin.	X	X	X	X	X		Moved to 061 04 02 04 (01)
(04)		State that for short distances the great circle is approximately a straight line.	X	X	X	X	X		Moved to 061 04 02 04 (01)
061 03 02 03		***Polar stereographic***							
(01)		State that meridians are straight lines radiating from the pole, which cut parallels of latitudes at right angles.	X		X	X			Moved to 061 04 02 02 (01)
(02)		State that parallels of latitude are concentric circles, and in this projection the distance apart increases away from the pole.	X		X	X			Moved to 061 04 02 02 (01)
(03)		State that great circles are approximately straight lines close to the pole. The exact great circle being concave to the pole.	X		X	X			Moved to 061 04 02 02 (01)
061 03 03 00		**The use of current aeronautical charts**							

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
061 03 03 01		***Plotting positions***							
(01)		Enter the position on a chart using range and bearing from a VORDME station, and derive geographical coordinates.	X	X	X	X	X		Moved to 061 04 03 02 (02)
(02)		Enter the positions on a chart using geographical coordinates and derive tracks and distances.	X	X	X	X	X		Moved to 061 04 03 02 (01)
(03)		Plot DME ranges on an aeronautical chart and derive geographical coordinates.	X	X	X	X	X		Moved to 061 04 03 02 (02)
(04)		Describe the methods used to provide information on chart scale. Use the chart scales stated and beware of the limitations of the stated scale for each projection.	X	X	X	X	X		Moved to 061 04 01 03 (01)
061 03 03 02		***Methods of indicating scale and relief***							
(01)		Describe the methods of representing relief and demonstrate the ability to interpret data.	X	X	X	X	X		Moved to 061 04 03 01 (01)
061 03 03 03		***Conventional signs***							
(01)		Interpret conventional signs and symbols on ICAO and other most frequently used charts.	X	X	X	X	X		Moved to 061 04 03 01 (01)
061 03 03 04		***Measuring tracks and distances***							
(01)		Given two positions, measure the track and the distance between them.	X	X	X	X	X		Moved to 061 04 03 02 (01)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
061 03 03 05		***Plotting bearings***							
~~LO (01)~~		~~Resolve bearings of an NDB station for plotting on an aeronautical chart.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(02)		Resolve radials from VOR stations for plotting on an aeronautical chart.	X	X	X	X	X		Moved to 061 04 03 02 (02)
061 04 00 00		**DEAD RECKONING (DR) NAVIGATION**							
061 04 01 00		**Basis of dead reckoning**							
(01)		Explain the triangle of velocities, e.g. true heading/TAS, W/V, and true track/GS.	X	X	X	X	X		Moved to 061 01 06 01 (01)
061 04 01 01		***Track***							
(01)		Explain the concept of vectors including adding together or splitting in two directions.	X	X	X	X	X		Moved to 061 01 06 02 (01)
061 04 01 02		***Heading (compass, magnetic, true, grid)***							
(01)		Calculate (compass, magnetic, true, grid) heading from given appropriate data.	X	X	X	X	X		Moved to 061 01 06 02 (01)
061 04 01 03		***Wind velocity***							
(01)		Calculate ~~wind velocity~~ from given appropriate data.	X	X	X	X	X		Moved to 061 01 06 02 (01)
061 04 01 04		***Airspeed (IAS, CAS, TAS, Mach number)***							

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(01)		Calculate TAS from IAS/CAS and Mach number from given appropriate data.	X	X	X	X	X		Moved to 061 01 05 01 (01) and 061 01 05 02 (01)
061 04 01 05		***Ground speed***							
(01)		Calculate ground speed from given appropriate data.	X	X	X	X	X		Moved to 061 01 05 04 (01), (02), (03) and (04)
(02)		Calculate ETA, flying time from distance, and GS.	X	X	X	X	X		Moved to 061 01 05 04 (05)
(03)		Calculate revised directional data for heading, track, course and W/V, e.g. true, magnetic, compass and grid from given appropriate data.	X	X	X	X	X		Moved to 061 01 06 02 (01)
061 04 01 07		***Drift, wind correction angle***							
(01)		Calculate drift and wind correction angle from given appropriate data.	X	X	X	X	X		Moved to 061 01 06 02 (01) and 061 01 03 02 (02)
061 04 02 00		**Use of the navigational computer**							
061 04 02 01		***Speed***							
(01)		Given appropriate data, determine speed.	X	X	X	X	X		Moved to 061 01 05 01 (01) and 061 01 05 02 (01)
061 04 02 02		***Time***							
(01)		Given appropriate data, determine time.	X	X	X	X	X		Moved to 061 01 05 04 (05)
061 04 02 03		***Distance***							

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(01)		Given appropriate data, determine distance.	X	X	X	X	X		Moved to 061 01 04 02 (01)
061 04 02 04		***Fuel consumption***							
~~LO (01)~~		~~Calculation of fuel used/fuel flow/flying time.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
061 04 02 05		***Conversions***							
~~LO (01)~~		~~Conversion between kilograms/ pounds/litres/U.S. gallons/imperial gallons.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
(02)		Conversion of distances. Kilometres/nautical miles/statute miles.	X	X	X	X	X		Moved to 061 01 04 02 (01)
(03)		Conversion of distances. Feet/metres.	X	X	X	X	X		Moved to 061 01 04 02 (01)
~~LO (04)~~		~~Conversion of volumes and weight of fuel using density in mass per unit volume.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
061 04 02 06		***Airspeed***							
(01)		Calculation of airspeed problems including IAS/EAS/CAS/TAS/ and M~~ach number~~ from given appropriate data.	X	X	X	X	X		Moved to 061 01 05 01 (01) and 061 01 05 02 (01)
061 04 02 07		***Wind velocity***							
(01)		Given appropriate data, determine wind velocity.	X	X	X	X	X		Moved to 061 01 06 02 (01)
061 04 02 08		***True altitude***							
~~LO (01)~~		~~Given appropriate data, determine true altitude/indicated~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 050

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		~~altitude/ density altitude.~~							
061 04 03 00		**The triangle of velocities**							
(01)		Solve problems to determine: — heading; — ground speed; — wind direction and speed; — track/course; — drift angle/wind correction angle; — head/tail/crosswind components.	X	X	X	X	X		Moved to 061 01 05 04 (01), 061 01 03 02 (02) and 061 01 06 02 (01)
061 04 04 00		**Determination of DR position**							
061 04 04 01		**Confirmation of flight progress (DR)**							
~~LO (01)~~		~~Describe the role and purpose of DR navigation.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to 061 01 07 01 (01)
~~LO (02)~~		~~Demonstrate mental DR techniques.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to 061 01 06 02 (01)
~~LO (03)~~		~~Define 'speed factor'. Speed divided by 60, used for mental flight path calculations.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (04)~~		~~Calculate head/tailwind component.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to 061 01 05 04 (01)
(05)		Calculate wind correction angle (WCA) using the formula: WCA = XWC (crosswind component)/SF (speed factor)	X	X	X	X	X		Moved to 061 02 02 01 (02)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(06)		Distance, speed and time calculations.	X	X	X	X	X		Moved to 061 01 05 04 (05) and 061 02 02 01 (02)
(07)		Demonstrate DR position graphically and by means of a DR computer.	X	X	X	X	X		Moved to 061 01 07 01 (01)
(08)		Given any four of the parts of the triangle of velocities, calculate the other two.	X	X	X	X	X		Moved to 061 01 06 02 (01)
(09)		Apply the validity of wind triangle symbols correctly. Heading vector one arrow, track/course vector two arrows, and W/V vector three arrows.	X	X	X	X	X		Moved to 061 01 06 01 (01)
061 04 04 02		**Lost procedures**							
(01)		Describe course of action when lost.	X	X	X	X	X		Moved to 061 02 02 02 (01)
061 04 05 00		**Measurement of DR elements**							
061 04 05 01		**Calculation of altitude, adjustments, corrections, errors**							
		Remark: For questions involving height calculation, 30 ft/hpa is to be used unless another figure is specified in the question.							
~~LO (01)~~		~~Calculate True Altitude (T ALT) from given indicated altitude, airfield elevation, Static Air Temperature (SAT)/Outside Air Temperature (OAT) and QNH/QFE.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 050
~~LO (02)~~		~~Calculate indicated altitude from given T ALT, airfield elevation, SAT/OAT and QNH/QFE.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 050

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
~~LO (03)~~		~~Calculate density altitude from given pressure altitude and SAT/OAT.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 050
~~LO (04)~~		~~Calculate density altitude from given airfield elevation, SAT/OAT and QNH/QFE.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 050
061 04 05 02		**Determination of temperature**							
~~LO (01)~~		~~Define 'OAT/SAT'. The temperature of the surrounding air.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 050
~~LO (02)~~		~~Define 'Ram Air Temperature (RAT)/ Total Air Temperature (TAT)/ Indicated Outside-Air Temperature (IOAT)'. The temperature measured by the temperature probe affected by friction and compressibility.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
~~LO (03)~~		~~Define 'ram rise'. The increase of temperature at the temperature probe due to friction and compressibility.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
~~LO (04)~~		~~RAT (TAT, IOAT) = OAT (SAT) + ram rise.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
~~LO (05)~~		~~Explain the difference in using OAT/SAT compared to RAT/TAT/IOAT in airspeed calculations.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 022
061 04 05 03		**Determination of appropriate speed**							
(01)		Explain the relationship between: — ~~IAS,~~ — CAS,	X	X	X	X	X		Moved to 061 01 05 03 (01) and (02)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		~~— EAS,~~ — and TAS.							
(02)		Calculate TAS from given IAS/CAS, OAT/SAT and pressure inputs.	X	X	X	X	X		Moved to 061 01 05 01 (01)
(03)		Calculate CAS from given TAS, OAT/SAT and pressure inputs.	X	X	X	X	X		Moved to 061 01 05 01 (01)
061 04 05 04		**Determination of Mach number**							
(01)		Calculate Mach number from given TAS and OAT/SAT.	X	X	X	X	X		Moved to 061 01 05 02 (01)
061 05 00 00		**IN-FLIGHT NAVIGATION**							
061 05 01 00		**Use of visual observations and application to in-flight navigation**							
(01)		Describe what is meant by the term ‘map reading’.	X	X	X	X	X		Moved to 061 02 02 01 (01)
(02)		Define the term ‘visual checkpoint’.	X	X	X	X	X		Moved to 061 02 01 01 (01)
(03)		Discuss the general features of a visual checkpoint and give examples.	X	X	X	X	X		Moved to 061 02 01 01 (01)
(04)		State that the evaluation of the differences between DR positions and actual position can refine flight performance and navigation.	X	X	X	X	X		Moved to 061 02 02 01 (02)
(05)		Establish fixes on navigational charts by plotting visually derived intersecting lines of position.	X	X	X	X	X		Moved to 061 02 02 01 (01)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(06)		Describe the use of a single observed position line to check flight progress.	X	X	X	X	X		Moved to 061 02 02 01 (01)
(07)		Describe how to prepare and align a map/chart for use in visual navigation.	X	X	X	X	X		Moved to 061 02 02 01 (01)
(08)		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.	X	X	X	X	X		Moved to 061 02 02 01 (01)
(09)		Describe the action to be taken if there is no visual checkpoint available at a scheduled turning point.	X	X	X	X	X		Moved to 061 02 02 02 (01)
(10)		Understanding 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	X	X	X	X	X		Moved to 061 02 01 02 (01)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		detailed and accurate charted data.							
(11)		State the function of contour lines on a topographical chart.	X	X	X	X	X		Moved to 061 02 02 01 (01)
(12)		Indicate the role of 'layer tinting' (colour gradient) in relation to the depiction of topography on a chart.	X	X	X	X	X		Moved to 061 02 01 01 (01)
(13)		Using the contours shown on a chart, describe the appearance of a significant feature.	X	X	X	X	X		Moved to 061 02 01 01 (01)
(24)		Understand that in areas of snow and ice from horizon to horizon and where the sky is covered with a uniform layer of clouds so that no shadows are cast, the horizon disappears, causing earth and sky to blend.	X	X	X	X	X		Moved to 061 02 01 02 (01)
061 05 02 00		**Navigation in climb and descent**							
061 05 02 01		**Average airspeed**							
~~LO (01)~~		~~Average TAS used for climb problems is calculated at the altitude 2/3 of the cruising altitude.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
~~LO (02)~~		~~Average TAS used for descent problems is calculated at the altitude 1/2 of the descent altitude.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
061 05 02 02		**Average wind velocity (WV)**							
~~LO (01)~~		~~WV used for climb problems is the WV at the altitude 2/3 of the cruising altitude.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
~~LO (02)~~		~~WV used for descent problems is the WV at the altitude 1/2 of the descent altitude.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
~~LO (03)~~		~~Calculate the average climb/descent GS from given TAS at various altitudes, WV at various altitudes and true track.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
~~LO (04)~~		~~Calculate the flying time and distance during climb/descent from given average rate of climb/descent and using average GS.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
~~LO (05)~~		~~Calculate the rate of descent on a given glide-path angle using the following formulae:~~ ~~valid for 3°-glide path:~~ ~~rate of descent = (GS (ground speed) × 10) / 2~~ ~~rate of descent = SF (speed factor) × glide-path angle × 100~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
~~LO (06)~~		~~Given distance, speed and present altitude, calculate the rate of climb/descent in order to reach a certain position at a given altitude.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
~~LO (07)~~		~~Given speed, rate of climb/descent and altitude, calculate the distance required in order to reach a position at a given altitude.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
~~LO (08)~~		~~Given speed, distance to go and altitude to climb/descent, calculate the rate of climb/descent.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(09)		State the effect on TAS and Mach number when climbing/descending with a constant CAS.							Moved to 061 01 05 03 (02)
061 05 02 03		**Ground speed/distance covered during climb or descent**							
~~LO (10)~~		~~State that most Aircraft Operating Handbooks supply graphical material to calculate climb and descent problems.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
~~LO (11)~~		~~Given distance, speed and present altitude, calculate the rate of climb/descent in order to reach a certain position at a given altitude.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
~~LO (12)~~		~~Given speed, rate of climb/descent and altitude, calculate the distance required in order to reach a certain position at a given altitude.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
061 05 02 04		**Gradients versus rate of climb/descent**							
~~LO (01)~~		~~Calculate climb/descent gradient (ft/NM, % and degrees), GS or vertical speed according to the following formulae:~~ ~~Vertical speed (feet/min) = (ground speed (kt) × gradient (feet/NM)) / 60~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
~~LO (02)~~		~~Gradient in % = altitude difference (feet) × 100 / ground difference (feet).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
~~LO (03)~~		~~Gradient in degrees = Arctg (Altitude difference (feet) / ground distance (feet)).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
~~LO (04)~~		~~Rate of climb/descent (feet/min) = gradient (%) × GS (kt).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
~~LO (05)~~		~~State that it is necessary to determine the position of the aircraft accurately before commencing descent in order to ensure safe ground clearance.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
061 05 03 00		**Navigation in cruising flight, use of fixes to revise navigation data**							
061 05 03 01		**Ground-speed revision**							
(01)		Calculate revised ground speed to reach a waypoint at a specific time.	X	X	X	X	X		Moved to 061 01 05 04 (05)
(02)		Calculate the average ground speed based on two observed fixes.	X	X	X	X	X		Moved to 061 01 05 04 (05)
~~LO (03)~~		~~Calculate the distance to the position passing abeam an NDB station by timing from the position with a relative bearing of 045/315 to the position abeam (relative bearing 090/270).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
061 05 03 02		**Off-track corrections**							
(01)		Calculate the track-error angle at a given course from A to B and an off- course fix, using the one-in-sixty rule.	X	X	X	X	X		Moved to 061 02 02 01 (02)
(02)		Calculate the heading change at an off-course fix to directly reach the next waypoint using the one-in-sixty rule.	X	X	X	X	X		Moved to 061 02 02 01 (02)
(03)		Calculate the average drift angle based upon an off-course fix	X	X	X	X	X		Moved to 061 02 02 01 (02)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		observation.							
061 05 03 03		**Calculation of wind speed and direction**							
(01)		Calculate the average wind speed and direction based on two observed fixes.	X	X	X	X	X		Moved to 061 01 06 02 (01)
061 05 03 04		**Estimated Time of Arrival (ETA) revisions**							
(01)		Calculate ETA revisions based upon observed fixes and revised ground speed.	X	X	X	X	X		Moved to 061 01 05 04 (05)
061 05 04 00		**Flight log**							
~~LO (01)~~		~~Given relevant flight-plan data, calculate the missing data.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
~~LO (02)~~		~~Enter the revised navigational en route data, for the legs concerned, into the flight log (e.g. updated wind and ground speed, and correspondingly losses or gains in time and fuel consumption).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033
~~LO (03)~~		~~Enter, in the progress of flight, at checkpoint or turning point, the 'actual time over' and the 'estimated time over' for the next checkpoint into the flight log.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Moved to Subject 033

New 061 document

SUBJECT 061 — GENERAL AND INERTIAL NAVIGATION

Mental dead reckoning (MDR)

Where the term 'mental dead reckoning' (MDR) is used within a Learning Objective (LO), the applicable technique which will be used for the European Central Question Bank (ECQB) questions is based on the methods shown below.

Examination questions will state that an MDR technique is required to produce the solution. If other techniques (e.g. trigonometry) are used to determine the answer, then the determined answer may be incorrect.

MDR crosswind component (XWC)

The XWC can be estimated using the values from the table below:

Wind angle	10°	20°	30°	40°	50°	60°
% of Wind speed	0.2	0.3	0.5	0.6	0.8	0.9

(Wind angle (WA) is the angle between the wind vector and the track/runway direction to the nearest 10°)

To assist recall, an aid is shown below:

Wind angle	10°	20°	30°	40°	50°	60°
Aid	1	1	2	2	3	3
% of Wind speed	0.2	0.3	0.5	0.6	0.8	0.9

Example:

RWY 04 and surface wind from tower is 080°/20 kt. What is the XWC?

WA = 40°

XWC = (0.6) × 20

= 12 kt

MDR headwind/tailwind component (H/TWC)

The H/TWC can be estimated using the values from the following table:

90° – wind angle	10°	20°	30°	40°	50°	60°

% of wind speed	**0.2**	**0.3**	**0.5**	**0.6**	**0.8**	**0.9**

To assist recall, an aid is shown below:

90° – wind angle	**10°**	**20°**	**30°**	**40°**	**50°**	**60°**
Aid	**1**	**1**	**2**	**2**	**3**	**3**
% of wind speed	**0.2**	**0.3**	**0.5**	**0.6**	**0.8**	**0.9**

Example:

RWY 04 and surface wind from tower is 080°/20 kt. What is the HWC?

WA = 40°

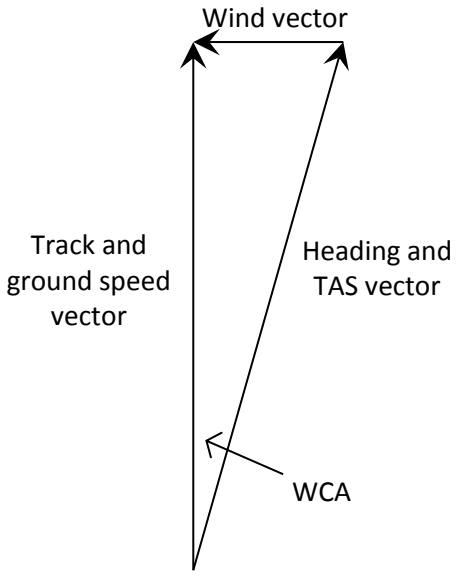
90° – WA = 50°

HWC = (0.8) × 20

= 16 kt

MDR triangle of velocities (TOV)

Heading is determined by calculating the XWC as previously described, then applying the 1:60 rule to the TOV as follows:



This MDR technique works for the relatively small WCAs which are typical for medium to high TAS values (the GS therefore can be assumed to be equal to the TAS for application of the 1:60 rule).

Example 1:

Planned track = 070° (T)

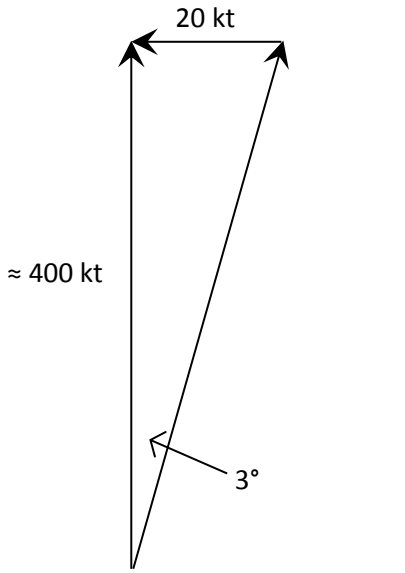
TAS = 400 kt

W/V = 100° (T)/40 kt

WA = 30°

XWC = (0.5) × 40

= 20 kt



Heading required = 073° (T)

Ground speed is determined by using the headwind/tailwind example previously explained.

WA = 30°

90° – 30° = 60°

HWC = (0.9) × 40

= 36 kt

Ground speed = 400 – 36 = 364 kt

Example 2:

Planned track = 327° (T)

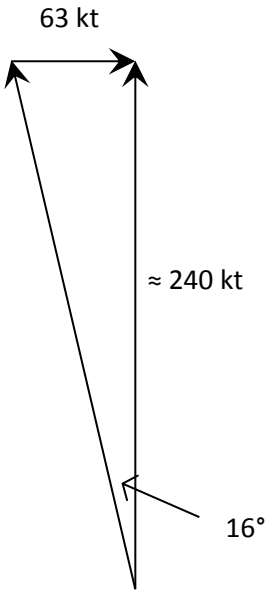
TAS = 240 kt

W/V = 210° (T)/70 kt

WA = 60°

XWC = (0.9) × 7

= 63 kt



WCA = 16°

Heading required = 311° (T)

Ground speed is determined by using the headwind/tailwind example previously explained.

WA = 60°

90° – 60° = 30°

TWC = (0.5) × 70

= 35 kt

Ground speed = 240 + 35 = 275 kt

VFR navigation (061 02 00 00)

The techniques referred to within the LOs are based on the methods as described below.

Mental dead reckoning (MDR) off-track corrections

Based on the 1:60 rule

1 NM of cross-track error (XTE) for every 60 NM along track from waypoint = 1° of track error angle (TKE).

1 NM of XTE for every 60 NM along track to way point = 1° of closing angle (CA).

Change of heading required to regain track in same distance as covered from waypoint to position off track = 2 × TKE.

Change of heading required to reach next waypoint from position off track = TKE + CA.

Example 1:

Planned heading is 162° (T), and after 40 NM along track the aircraft position is fixed 2 NM right of planned track. What heading is required to regain track in approximately the same time as has taken to the fix position?

TKE = 3°

Heading required = 156° (T)

Example 2:

Planned heading is 317° (T), and after 22 NM along track the aircraft position is fixed 3.5 NM left of planned track. What heading is required to fly direct to the next waypoint which is another 45 NM down track?

TKE = 10°, CA = 5°

Heading required = 332° (T)

Mental dead reckoning (MDR) ETA calculations

Round the GS to the nearest NM/min, and then make the same percentage adjustment for the distance.

Example:

Distance to go = 42 NM

GS = 132 kt

GS rounded to 120 kt = 2 NM/min

Percentage change = 10 %

Distance = 42 – 10 % = 38 NM

Time = 38 / 2 = 19 min

Unsure-of-position procedure

As soon as the position of the aircraft is in doubt:

1. note the time;
2. communicate if in touch with an ATC unit to request assistance;
3. consider any radio navigation aids that may be usable (do not become distracted from flying the aircraft safely);
4. if short of fuel or near controlled airspace, and not in contact with ATC, set 121.5 MHz and make a PAN call;
5. if that is not necessary, check the directional indicator (DI) and compass are still synchronised and continue to fly straight and level and on route plan heading;
6. estimate the distance travelled since the last known position;
7. compare the ground with your estimated position on the map (look at the terrain for hills and valleys or line features such as a motorway, railway, river or coastline);
8. once the position has been re-established, keep checking the heading (and look out for other aircraft) and continue the flight by updating the estimated position regularly while looking for unique features such as a lake, wood, built-up area, mast, or a combination of roads, rivers and railways.

Procedure when lost

If the unsure-of-position procedure does not resolve the problem:

1. inform someone — call first on the working frequency and state the word ‘LOST’;

2. if there is no contact on that frequency or there is no frequency selected, change to 121.5 MHz and make a PAN call; select 7700 with ALT on the transponder if fitted.

In all cases — maintain VMC, note the fuel state, and try to identify an area suitable for a precautionary landing.
Consider the 'HELP ME' mnemonic:

H. High ground/obstructions — are there any nearby?

E. Entering controlled airspace — is that a possibility?

L. Limited experience, low time or student pilot — let someone know.

P. PAN call in good time — don't leave it too late.

M. MET conditions — is the weather deteriorating?

E. Endurance — is fuel getting low?

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
060 00 00 00		**NAVIGATION**							
061 00 00 00		**GENERAL AND INERTIAL NAVIGATION**							
061 01 00 00		**BASICS OF NAVIGATION**							
061 01 01 00		**The Earth**							
061 01 01 01		***Form***							
(01)	X	State that the geoid is an irregular shape based on the surface of the oceans influenced only by gravity and centrifugal force.	X	X	X	X	X		
(02)	X	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.	X	X	X	X	X		
(03)		State that the circumference of the Earth is approximately 40 000 km.	X	X	X	X	X		
061 01 01 02		***Earth rotation***							
(01)	X	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).	X	X	X	X	X		
(02)		Explain the effect that the inclination of the Earth's spin axis has on insolation and duration of daylight.	X	X	X	X	X		
061 01 01 03		***Earth rotation***							
061 01 02 00		**Position**							

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
061 01 02 01		***Position reference system***							
(01)	X	State that geodetic latitude and longitude is used to define a position on the WGS-84 ellipsoid.	X	X	X	X	X		
(02)		Define geographic (geodetic) latitude and parallels of latitude.	X	X	X	X	X		
(03)		Calculate the difference in latitude between any two given positions.	X	X	X	X	X		
(04)		Define geographic (geodetic) longitude and meridians.	X	X	X	X	X		
(05)		Calculate the difference in longitude between any two given positions.	X	X	X	X	X		
061 01 03 00		**Direction**							
061 01 03 01		***Datums***							
(01)	X	Define true north (TN).	X	X	X	X	X		
(02)		Measure a true direction on any given aeronautical chart.	X	X	X	X	X		
(03)	X	Define magnetic north (MN).	X	X	X	X	X		
(04)		Define and apply variation.	X	X	X	X	X		
(05)		Explain changes of variation with time and position.	X	X	X	X	X		
(06)	X	Define compass north (CN).	X	X	X	X	X		
(07)		Apply deviation.	X	X	X	X	X		
061 01 03 02		***Track and heading***							

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(01)		Calculate XWC by: — trigonometry, and — MDR.							
(02)		Explain and apply the concepts of drift and WCA.	X	X	X	X	X		
(03)		Calculate the track made good (TMG) with appropriate data of heading and drift.	X	X	X	X	X		
(04)		Calculate the track angle error (TKE) with appropriate data of WCA and drift.	X	X	X	X	X		
061 01 04 00		**Distance**							
061 01 04 01		***WGS-84 ellipsoid***							
(01)	X	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.	X	X	X	X	X		
(02)		State that 1' of longitude change at the equator on the WGS-84 ellipsoid is approximately equal to 1 NM.	X	X	X	X	X		
061 01 04 02		***Units***							
(01)		Convert between units of distance (nautical mile (NM), kilometre (km), statute mile (stm), feet (ft), inches (ins)).	X	X	X	X	X		
061 01 04 03		***Graticule distances***							
(01)		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	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		given distances north-south and east-west.							
061 01 04 04		***Air mile***							
(01)		Evaluate the effect of wind and altitude on ground distance.	X	X	X	X	X		
(02)		Convert between ground distance (NM) and air distance (NAM) using the formula NAM = NM × TAS/GS.	X	X	X	X	X		
061 01 05 00		**Speed**							
061 01 05 01		***True airspeed (TAS)***							
(01)		Calculate TAS from CAS and CAS from TAS by: — mechanical computer; and — rule of thumb (2 % per 1 000 ft).	X	X	X	X	X		
061 01 05 02		***Mach number (M)***							
(01)		Calculate TAS from M and M from TAS.	X	X					
061 01 05 03		***CAS/TAS/M relationship***							
(01)		Deduce the CAS, TAS and M relationship in climb/descent/cruise (flying at constant CAS or M).	X	X					
(02)		Deduce CAS and TAS climb/descent/cruise (flying at constant CAS).			X	X	X		
061 01 05 04		***Ground speed***							
(01)		Calculate headwind and tailwind component by: — trigonometry; and	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		— mental dead reckoning (MDR).							
(02)		Apply headwind component (HWC) and tailwind component (TWC) to determine GS from TAS and vice versa.							
(03)	X	Explain the relationship between ground speed and TAS with increasing WCA.	X	X	X	X	X		
(04)		Calculate ground speed with: — mechanical computer (triangle of velocities (TOV) solution); and — MDR (given track, TAS and W/V).	X	X	X	X	X		
(05)		Perform ground speed, distance and time calculations.	X	X	X	X	X		
061 01 06 00		**Triangle of velocities (TOV)**							
061 01 06 01		***Construction***							
(01)		Draw and correctly label the TOV.	X	X	X	X	X		
061 01 06 02		***Solutions***							
(01)		Resolve the TOV for: — heading and ground speed (with mechanical computer and MDR); — W/V (with mechanical computer and MDR); and — track and ground speed (with mechanical computer and MDR.	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
061 01 07 00		**Dead reckoning (DR)**							
061 01 07 01		***Dead reckoning (DR) technique***							
(01)		Determine a DR position.	X	X	X	X	X		
(02)		Evaluate the difference between a DR and fix position.	X	X	X	X	X		
061 02 00 00		**VISUAL FLIGHT RULE (VFR) NAVIGATION**							
061 02 01 00		**Ground features**							
061 02 01 01		***Ground features***							
(01)		Recognise which elements would make a ground feature suitable for use for VFR navigation.	X	X	X	X	X		
061 02 01 02		***Visual identification***							
(01)		Describe the problems of VFR navigation at lower levels and the causes of reduced visibility.	X	X	X	X	X		
(02)		Describe the problems of VFR navigation at night.	X	X	X	X	X		
061 02 02 00		**VFR navigation techniques**							
061 02 02 01		***Dead reckoning (DR)***							
(01)		Apply the techniques of DR, map reading, orientation, timing and revision of ETAs and headings.	X	X	X	X	X		
061 02 02 02		***Unplanned events***							
(01)		Explain what needs to be considered in case of diversion, when	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		unsure of position and when lost.							
061 03 00 00		**GREAT CIRCLES AND RHUMB LINES**							
061 03 01 00		**Great circles**							
061 03 01 01		***Properties***							
(01)		Describe the geometric properties of a great circle (including the vertex) and a small circle.	X	X					
(02)		Describe the geometric properties of a great circle and a small circle.			X	X	X		
(01)	X	Explain why a great circle route is the shortest distance between any two positions on the Earth.	X	X	X	X	X		
061 03 01 02		***Convergence***							
(01)	X	Explain why the track direction of a great circle route (other than following a meridian or the equator) changes.	X	X	X	X	X		
(02)		State the formula used to approximate the value of Earth convergence as change of longitude × sine mean latitude.	X	X	X	X	X		
(03)		Calculate the approximate value of Earth convergence between any two positions.	X	X	X	X	X		
061 03 02 00		**Rhumb lines**							
061 03 02 01		***Properties***							
(01)	X	Describe the geometric properties of a rhumb line.	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(02)	X	State that a rhumb line route is not the shortest distance between any two positions on the Earth (excluding meridians and equator).	X	X	X	X	X		
(03)	X	Explain that the true track direction of a rhumb line route does not change.	X	X	X	X	X		
061 03 03 00		**Relationship**							
061 03 03 01		***Distances***							
(01)		Explain that the variation in distance of the great circle route and rhumb line route between any two positions increases with increasing latitude and/or change in longitude.	X	X	X	X	X		
061 03 03 02		***Conversion angle***							
(01)		Calculate and apply the conversion angle.	X	X					
061 04 00 00		**CHARTS**							
061 04 01 00		**Chart requirements**							
061 04 01 01		***ICAO Annex 4***							
(01)		State the requirement for conformality and for a straight line to approximate a great circle.	X	X	X	X	X		
061 04 01 02		***Convergence***							
(01)		Explain and calculate the constant of the cone (sine of parallel of origin).	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(02)		Explain the relationship between Earth and chart convergence with respect to the ICAO requirement for a straight line to approximate a great circle.	X	X	X	X	X		
061 04 01 03		***Scale***							
(01)		Recognise methods of representing scale on aeronautical charts.	X	X	X	X	X		
(02)		Perform scale calculations based on typical en-route chart scales.	X	X	X	X	X		
061 04 02 00		**Projections**							
061 04 02 01		***Projections methods***							
(01)	X	Identify azimuthal, cylindrical and conical projections.	X	X	X	X	X		
061 04 02 02		***Polar stereographic***							
(01)		State the properties of a polar stereographic projection.	X	X	X	X	X		
(02)		Calculate straight line track changes on a polar stereographic chart.	X	X	X	X	X		
061 04 02 03		***Direct Mercator***							
(01)		State the properties of a direct Mercator projection.	X	X	X	X	X		
061 04 02 04		***Lambert***							
(01)		State and apply the properties of a Lambert projection.	X	X	X	X	X		
(02)		Calculate straight line track changes on a Lambert chart.	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
061 04 03 00		**Practical use**							
061 04 03 01		***Symbology***							
(01)		Recognise ICAO Annex 4 symbology.	X	X	X	X	X		
061 04 03 02		***Plotting***							
(01)		Measure tracks and distances on VFR and IFR en-route charts.	X	X	X	X	X		
(02)		Fix the aircraft position on an en-route chart with information from VOR and DME equipment.	X	X	X	X	X		
061 05 00 00		**Time**							
061 05 01 00		**Local Mean Time (LMT)**							
061 05 01 01		***Mean solar day***							
(01)	X	Explain the concepts of a mean solar day and LMT.	X	X	X	X	X		
061 05 01 02		***Local Mean Time (LMT) and Greenwich Mean Time (GMT)***							
(01)		Perform LMT and GMT calculations.	X	X	X	X	X		
061 05 02 00		**Standard time**							
061 05 02 01		***Standard time and daylight saving time***							
(01)		Apply the concept of standard time and daylight saving time and perform standard time and daylight saving time calculations.	X	X	X	X	X		
061 05 02 02		***International Date Line***							

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(01)		State the changes when crossing the International Date Line.	X	X	X	X	X		
061 05 03 00		**Sunrise and sunset**							
061 05 03 01		***Sunrise and sunset times***							
(01)		Define sunrise, sunset, and civil twilight, and extract times from a suitable source (e.g. an almanac).	X	X	X	X	X		
(02)		Explain the changes to sunrise, sunset, civil twilight times with date, latitude and altitude.	X	X	X	X	X		
061 06 00 00		**Inertial navigation**							New topic Moved from 022 05 00 and amended
061 06 01 00		**Basic principles**							
(01)		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.	X		X	X			
(02)		State that inertial systems require no external input to determine aircraft attitude and navigational data.	X						
(03)	X	State that earlier gyro mechanical 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).	X						

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(04)		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).	X						
(05)		Explain the necessity of applying correction for transport precession and Earth rate precession.	X						
(06)		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.	X						
(07)		List all navigational data that can be determined by a stand-alone inertial system.	X						
(08)	X	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.	X						
(09)	X	Explain the fundamental differences between a laser ring gyro and a conventional mechanical gyro.	X						
061 06 02 00		**Alignment and operation**							
(01)		State that during the alignment process the inertial platform is levelled and the aircraft heading determined.	X						
(02)		Explain that the aircraft must be stationary during alignment, the	X						

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
		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).							
(03)		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.	X						
(04)	X	Explain that the inertial navigation system (INS) platform is maintained level and north-aligned after alignment is complete and the aircraft is in motion.	X						
(05)		State that an incorrect entry of latitude may lead to a loss of alignment and is more critical than the incorrect entry of longitude.	X						
(06)	X	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.	X						
(07)		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).	X						
(08)	X	Identify examples of IRS control panels.	X						
(09)		Explain the following selections on the IRU mode selector: — NAV (normal operation); — ATT (attitude only).	X						

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	Comments
			ATPL	CPL	ATPL /IR	ATPL	CPL		
(10)		Identify where the majority of the IRS data can be accessed through the FMS control and display unit (CDU)/flight management and guidance system (FMGS) multifunctional control and display unit (MCDU).	X						
(11)		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.	X						

Overview of the proposed amendments to Subject 062 'Radio navigation'

The basic radio navigation Learning Objectives (LOs) contained a lot of basic knowledge that can be expected to be learned in preceding courses before entry to the approved training organisation (ATO), so the remaining LOs for examination have been decreased.

Microwave landing system (MLS) is very rarely used in aviation. Global navigation satellite system (GNSS) appears to play a bigger role in approaches. A further use of MLS is not expected. For this reason, the LOs for MLS have been deleted.

Mode S is worldwide in use. Pilots should have knowledge of secondary surveillance radar (SSR) Mode S.

Area navigation is replaced by performance-based navigation (PBN). The LOs for PBN have been taken over as prepared by the previous EASA rulemaking task on PBN and published with ED Decision 2016/008/R[1].

The LOs concerning flight management system (FMS) and electronic flight instrument system (EFIS) have been transferred to aircraft general knowledge (AGK) instruments (022 11 00 00 and 022 13 03 00 respectively).

[1] Executive Director Decision 2016/008/R of 2 May 2016 amending the Acceptable Means of Compliance and Guidance Material to Part-FCL and Part-ARA of Commission Regulation (EU) No 1178/2011, as amended, and the Acceptable Means of Compliance and Guidance Material to Part-ORO and Part-ARO of Commission Regulation (EU) No 965/2012, as amended (http://www.easa.europa.eu/document-library/agency-decisions/ed-decision-2016008r).

SUBJECT 062 — RADIO NAVIGATION

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
060 00 00 00		**NAVIGATION**								
062 00 00 00		**RADIO NAVIGATION**								
062 01 00 00		**BASIC RADIO PROPAGATION THEORY**								
062 01 01 00		**Basic principles**								
062 01 01 01		***Electromagnetic waves***								
(01)	X	State that radio waves travel at the speed of light, being approximately 300 000 km/s ~~or 162 000 NM/s~~.	X	X	X	X	X	X		Speed in NM/s not in use in aviation
(02)	X	Define ‘cycle’. A complete series of values of a periodical process.	X	X	X	X	X	X		
(03)	X	Define ‘Hertz’ (Hz)~~.~~’. 1 Hertz is 1 cycle per second.	X	X	X	X	X	X		
062 01 01 02		***Frequency, wavelength, amplitude, phase angle***								
(01)	X	Define ‘frequency’~~.~~: ~~T~~the number of cycles occurring in 1 second in a radio wave expressed in Hertz (Hz).	X	X	X	X	X	X		
(02)	X	Define ‘wavelength’: the physical distance travelled by a radio wave during one cycle of transmission.	X	X	X	X	X	X		
(03)	X	Define ‘amplitude’: the maximum deflection in an oscillation or wave.	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(04)	X	State that the relationship between wavelength and frequency is: — wavelength (λ) = speed of light (c) / frequency (f)~~;~~. ~~— or λ (meters) = 300 000 / kHz.~~	X	X	X	X	X	X		Double notation of formula; speed of light should be known by heart
(05)	X	Define 'phase': the fraction of one wavelength expressed in degrees from 000° to 360°.	X	X	X	X	X	X		
(06)	X	Define 'phase difference/shift': the angular difference between the corresponding points of two cycles of equal wavelength, which is measurable in degrees.	X	X	X	X	X	X		
062 01 01 03		***Frequency bands, sidebands, single sideband***								
(01)		List the bands of the frequency spectrum for electromagnetic waves: ~~— Very Low Frequency (VLF): 3–30 kHz;~~ — l~~L~~ow f~~F~~requency (LF): 30–300 kHz; — m~~M~~edium f~~F~~requency (MF): 300–3 000 kHz; — h~~H~~igh f~~F~~requency (HF): 3–30 MHz; — v~~V~~ery h~~H~~igh f~~F~~requency (VHF): 30–300 MHz; — u~~U~~ltra h~~H~~igh f~~F~~requency (UHF): 300–3 000 MHz; — s~~S~~uper h~~H~~igh f~~F~~requency (SHF): 3–30 GHz; — e~~E~~xtremely h~~H~~igh f~~F~~requency (EHF): 30–300 GHz.	X	X	X	X	X	X		VLF not in use

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~LO (02)~~		~~State that when a carrier wave is modulated, the resultant radiation consists of the carrier frequency plus additional upper and lower sidebands.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (03)~~		~~State that HF VOLMET and HF two-way communication use a single sideband.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (04)~~		~~State that a radio signal may be classified by three symbols in accordance with the ITU Radio Regulation, Volume 1: e.g. A1A.~~ ~~— The first symbol indicates the type of modulation of the main carrier;~~ ~~— The second symbol indicates the nature of the signal modulating the main carrier;~~ ~~— The third symbol indicates the nature of the information to be transmitted.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
062 01 01 04		***~~Pulse characteristics~~ Intentionally left blank***								
~~LO (01)~~		~~Define the following terms as associated with a pulse string:~~ ~~— pulse length,~~ ~~— pulse power,~~ ~~— continuous power.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
062 01 01 05		***Carrier, modulation***								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(01)	X	Define 'carrier wave': the radio wave acting as the carrier or transporter.	X	X	X	X	X	X		
(02)	X	Define 'keying': interrupting the carrier wave ~~to break it into dots and dashes~~.	X	X	X	X	X	X		
(03)	X	Define 'modulation': the technical term for the process of impressing and transporting information by radio waves.	X	X	X	X	X	X		
062 01 01 06		***Kinds of modulation (amplitude, frequency, pulse, phase)***								
(01)	X	Define 'amplitude modulation': the information that is impressed onto the carrier wave by altering the amplitude of the carrier.	X	X	X	X	X	X		
(02)	X	Define 'frequency modulation': the information that is impressed onto the carrier wave by altering the frequency of the carrier.	X	X	X	X	X	X		
(03)	X	Describe 'pulse modulation': a modulation form used in radar by transmitting short pulses followed by larger interruptions.	X	X	X	X	X	X		
(04)	X	Describe 'phase modulation': a modulation form used in GPS where the phase of the carrier wave is reversed.	X	X	X	X	X	X		
062 01 02 00		**Antennas**								
062 01 02 01		***Characteristics***								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(01)	X	Define 'antenna': a wave-type transducer for the process of converting a line AC into a free electromagnetic wave.	X	X	X	X	X	X		
(02)	X	State that the simplest type of antenna is a dipole which is a wire of length equal to one half of the wavelength.	X	X	X	X	X	X		
~~LO (03)~~		~~State that in a wire which is fed with an AC (alternating current), some of the power will radiate into space.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Outdated due to modern technologies
~~LO (04)~~		~~State that in a wire parallel to the wire fed with an AC but remote from it, an AC will be induced.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Outdated due to modern technologies
(05)	X	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.	X	X	X	X	X	X		
(06)	X	State that the ~~(~~E~~)~~ and ~~(~~H~~)~~ fields are perpendicular to each other. The oscillations are perpendicular to the propagation direction and are in-phase.	X	X	X	X	X	X		
~~LO (07)~~		~~State that the electric field is parallel to the wire and the magnetic field is perpendicular to it.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Irrelevant
062 01 02 02		***Polarisation***								
(01)	X	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.	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~LO (02)~~		~~State that in linear polarisation the plane of oscillation is fixed in space, whereas in circular (eliptical) polarisation the plane is rotating.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Irrelevant
(03)	X	Explain the difference between horizontal and vertical polarisation in the dependence of the alignment of the ~~dipole~~ antenna.	X	X	X	X	X	X		Adjusted due to modern radio technology
062 01 02 03		***Types of antennas***								
(01)		~~List and describe~~Name the common different kinds 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; — helical antenna used in GPS transmitters.	X	X	X	X	X	X		Description not required
062 01 03 00		**Wave propagation**								
062 01 03 01		***Structure of the ionosphere***								
(01)	X	State that the ionosphere is the ionised component of the Earth's upper atmosphere from 60 ~~km~~ to 400 km above the surface, which is vertically structured in three regions or layers.	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(02)	X	State that the layers in the ionosphere are named D, E and F layers, and their depth varies with time.	X	X	X	X	X	X		
(03)	X	State that electromagnetic waves refracted from the E and F layers of the ionosphere are called sky waves.	X	X	X	X	X	X		
062 01 03 02		***Ground waves***								
(01)	X	Define 'ground or surface waves': the electromagnetic waves travelling along the surface of the Earth.	X	X	X	X	X	X		
062 01 03 03		***Space waves***								
(01)	X	Define 'space waves': the electromagnetic waves travelling through the air directly from the transmitter to the receiver.	X	X	X	X	X	X		
062 01 03 04		***Propagation with the frequency bands***								
(01)		State that radio waves in VHF, UHF, SHF and EHF propagate as space waves.	X	X	X	X	X	X		
(02)		State that radio waves in ~~VLF,~~ LF, MF and HF propagate as surface/ground waves and sky waves.	X	X	X	X	X	X		
062 01 03 05		***Doppler principle***								
(01)	X	State that the Doppler effect is the phenomenon ~~that~~ where the frequency of an electromagnetic wave will increase or decrease if there is relative motion between	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		the transmitter and the receiver.								
~~LO (02)~~		~~State that the frequency will increase if the transmitter and receiver are converging, and will decrease if they are diverging.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Duplication of 062 01 03 05 (01)
062 01 03 06		***Factors affecting propagation***								
(01)	X	Define 'skip distance': the distance between the transmitter and the point on the surface of the Earth where the first sky return arrives.	X	X	X	X	X	X		
~~LO (02)~~		~~State that skip zone/dead space is the distance between the limit of the surface wave and the sky wave.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(03)		Describe 'fading': when a receiver picks up the sky signal and the surface signal, the signals will interfere with each other causing the signals to be cancelled out.	X	X	X	X	X	X		
(04)		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.	X	X	X	X	X	X		
(05)	X	Describe the physical phenomena reflection, refraction, diffraction, absorption and interference.	X	X	X	X	X	X		
062 02 00 00		**RADIO AIDS**								
062 02 01 00		**Ground direction finding (D~~/~~F)**								
062 02 01 01		***Principles***								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(01)	X	Describe the use of a g~~G~~round ~~Direction Finder~~DF.	X	X	X	X	X	X		
~~LO (02)~~		~~Explain why the service provided is subdivided as:~~ ~~- VHF direction finding (VDF)~~ ~~- UHF direction finding (UDF).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Irrelevant
(03)		Explain the limitation of range because of the path of the VHF signal.	X	X	X	X	X	X		
~~LO (04)~~		~~Describe the operation of the VDF in the following general terms:~~ ~~— radio waves emitted by the radio-telephony (R/T) equipment of the aircraft;~~ ~~— special directional antenna;~~ ~~— determination of the direction of the incoming signal;~~ ~~— ATC display.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Irrelevant
062 02 01 02		***Presentation and interpretation***								
(01)		Define the term 'QDM': the magnetic bearing to the station.	X	X	X	X	X	X		
(02)		Define the term 'QDR': the magnetic bearing from the station.	X	X	X	X	X	X		
~~LO (03)~~		~~Define the term 'QUJ'. The true bearing to the station.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Outdated

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~LO (04)~~		~~Define the term 'QTE'. The true bearing from the station.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Outdated
~~LO (05)~~		~~Explain that by using more than one ground station, the position of an aircraft can be determined and transmitted to the pilot.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Irrelevant
062 02 01 03		***Coverage and range***								
(01)		Use the formula: *1.23 × √transmitter height in feet + 1.23 × √receiver height in feet*, to calculate the range in NM.	X	X	X	X	X	X	X	
062 02 01 04		***Errors and accuracy***								
(01)	X	Explain why synchronous transmissions will cause errors.	X	X	X	X	X	X		
(02)	X	Describe the effect of 'multipath signals'.	X	X	X	X	X	X		
(03)		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.	X	X	X	X	X	X		
062 02 02 00		**Non-d~~D~~irectional b~~B~~eacon (NDB)/a~~A~~utomatic d~~D~~irection**								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		f~~F~~inder (ADF)								
062 02 02 01		***Principles***								
(01)	X	Define the acronym 'NDB': n~~N~~on-d~~D~~irectional b~~B~~eacon.	X	X	X	X	X	X	X	
(02)	X	Define the acronym 'ADF': a~~A~~utomatic d~~D~~irection f~~F~~inder.	X	X	X	X	X	X	X	
(03)	X	State that the NDB is the ground part of the system.	X	X	X	X	X	X	X	
(04)	X	State that the ADF is the airborne part of the system.	X	X	X	X	X	X	X	
(05)		State that the NDB operates in the LF and MF frequency bands.	X	X	X	X	X	X	X	
(06)		The frequency band assigned to aeronautical NDBs according to ICAO Annex 10 is 190–1 750 kHz.	X	X	X	X	X	X	X	
(07)		Define a 'locator beacon': an LF/MF NDB used as an aid to final approach usually with a range~~,~~ of 10–25 NM.	X	X	X	X	X	X	X	
~~LO (08)~~		~~Explain the difference between NDBs and locator beacons.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of 062 02 02 01 07
~~LO (09)~~		~~Explain which beacons transmit signals suitable for use by an ADF.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of 062 02 02 01 05 and 062 02 02 01 10
(10)	X	State that certain commercial radio stations transmit within the frequency band of the NDB.	X	X	X	X	X	X	X	
(11)	X	Explain why it is necessary to use a directionally sensitive	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		receiver antenna system in order to obtain the direction of the incoming radio wave.								
(12)		Describe the use of NDBs for navigation.	X	X	X	X	X	X	X	
(13)		Describe the procedure to identify an NDB station.	X	X	X	X	X	X	X	
(14)	X	Interpret the term 'cone of ~~silence~~ confusion' in respect of an NDB.	X	X	X	X	X	X	X	There is no silence right above the beacon, but to bear the direction is the problem
(15)	X	State that an NDB station emits a NON/A1A or a NON/A2A signal.	X	X	X	X	X	X	X	
(16)	X	State the function of the b~~B~~eat f~~F~~requency o~~O~~scillator (BFO).	X	X	X	X	X	X	X	
(17)	X	State that in order to identify a NON/A1A NDB, the BFO circuit of the receiver has to be activated.	X	X	X	X	X	X	X	
~~LO (18)~~		~~State that the NDB emitting NON/A1A gives rise to erratic indications of the bearing while the station is identifying.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use and probably not true
(19)	X	Explain that on modern aircraft the BFO is activated automatically.	X	X	X	X	X	X	X	
062 02 02 02		***Presentation and interpretation***								
(01)	X	Name the types of indicators commonly in use ~~in common use~~:	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		— electronic navigation display; — ~~r~~Radio m~~M~~agnetic i~~I~~ndicator (RMI); — fixed card ADF (radio compass); — moving card ADF.								
(02)		~~Describe~~ Interpret the indications given on RMI, fixed card and moving card ADF displays.	X	X	X	X	X	X	X	More practical wording
(03)		Given a display, interpret the relevant ADF information.	X	X	X	X	X	X	X	
(04)		Calculate the true bearing from the compass heading and relative bearing.	X	X	X	X	X	X	X	
(05)		Convert the compass bearing into magnetic bearing and true bearing.	X	X	X	X	X	X	X	
(06)		Describe how to fly the following in-flight ADF procedures according to ICAO Doc 8168, Volume 1: — homing and tracking, and explain the influence of wind; — interceptions; — procedural turns; — holding patterns.	X	X	X	X	X	X	X	
062 02 02 03		***Coverage and range***								
(01)	X	State that the power limits the range of an NDB.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~LO (02)~~		~~Explain the relationship between power and range.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use
~~LO (03)~~		~~State that the range of an NDB over sea is better than over land due to better ground wave propagation over seawater than over land.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use
(04)	X	Describe the propagation path of NDB radio waves with respect to the ionosphere and the Earth's surface.	X	X	X	X	X	X	X	
(05)		Explain that interference between sky and ground waves at night leads to 'fading'.	X	X	X	X	X	X	X	
(06)		Define the accuracy the pilot has to fly the required bearing in order to be considered established during approach according to ICAO Doc 8168 as within ± 5°.	X	X	X	X	X	X	X	
(07)		State that there is no warning indication of NDB failure.	X	X	X	X	X	X	X	
062 02 02 04		***Errors and accuracy***								
~~LO (01)~~		~~Define 'quadrantal error'. The distortion of the incoming signal from the NDB station by reradiation from the airframe. This is corrected for during installation of the antenna.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use
(02)	X	Explain 'coastal refraction': as a radio wave travelling over land crosses the coast, the wave speeds up over water and the wave front bends.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(03)	X	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.	X	X	X	X	X	X	X	
~~LO (04)~~		~~State that interference from other NDB stations on the same frequency may occur at night due to sky-wave contamination.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use
062 02 02 05		***Factors affecting range and accuracy***								
~~LO (01)~~		~~State that there is no coastal refraction error when:~~ ~~— the propagation direction of the wave is 90° to the coastline;~~ ~~— the NDB station is sited on the coastline.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use
~~LO (02)~~		~~State that coastal refraction error increases with increased incidence.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use
~~LO (03)~~		~~State that night effect predominates around dusk and dawn.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use
(04)		~~Define multipath propabation~~ Describe diffraction of radio waves in mountainous terrain (mountain effect).	X	X	X	X	X	X	X	Terminology corrected
(05)		State that static emission energy from a cumulonimbus cloud may interfere with the radio wave and influence the ADF bearing indication.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(06) New		Explain that a bank angle of the aircraft causes a dip error.	X	X	X	X	X	X	X	It is an error that is relevant for practical use with interceptions
062 02 03 00		**VHF omnidirectional radio range (VOR) and Doppler VOR**								
062 02 03 01		***Principles***								
(01)	X	Explain the operation of VOR using the following general terms: — reference phase; — variable phase; — phase difference.	X	X	X	X	X	X		
(02)		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.	X	X	X	X	X	X	X	
(03)		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).	X	X	X	X	X	X	X	
~~LO (04)~~		~~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~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~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 airports;~~ — ~~Test VOR (VOT): a VOR station emitting a signal to test VOR indicators in an aircraft.~~								
(05)		State ~~Describe how~~ that automatic terminal information service (ATIS) information is transmitted on VOR frequencies.	X	X	X	X	X	X	X	LO level improved
(06)	X	List the three main components of VOR airborne equipment: — the antenna; — the receiver; — the indicator.	X	X	X	X	X	X	X	
(07)		Describe the identification of a VOR in terms of Morse code letters ~~letter, continous tone or dots (VOT), tone pitch, repetition rate~~ and additional plain text.	X	X	X	X	X	X	X	VOT is outdated
(08)	X	State that according to ICAO Annex 10, a VOR station has	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		an automatic ground monitoring system.								
~~LO (09)~~		~~State that the VOR monitoring system monitors change in measured radial and reduction in signal strength.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Irrelevant
(10)		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.	X	X	X	X	X	X	X	
062 02 03 02		**Presentation and interpretation**								
(01)		Read off the radial on an ~~Radio Magnetic Indicator (~~RMI~~)~~.	X	X	X	X	X	X		
(02)		Read off the angular displacement in relation to a preselected radial on a~~n~~ horizontal situation indicator (HSI) or course deviation indicator (CDI).	X	X	X	X	X	X		
(03)		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~~.	X	X	X	X	X	X		TO/FROM indicator is irrelevant to the heading of the aircraft
(04)		Interpret VOR information as displayed on HSI, CDI and RMI.	X	X	X	X	X	X		
(05)		Describe the following in-flight VOR procedures as in ICAO Doc 8168, Volume 1: — tracking, and explain the influence of wind when tracking;	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		— interceptions; — procedural turns; — holding patterns.								
(06)		State that when converting a radial into a true bearing, the variation at the VOR station has to be taken into account.	X	X	X	X	X	X		
062 02 03 03		***~~Coverage and range~~ Intentionally left blank***								
~~LO (01)~~		~~Describe the range with respect to the transmitting power and radio signal.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~			Irrelevant
~~LO (02)~~		~~Calculate the range using the formula:~~ ~~1.23 × √transmitter height in feet + 1.23 × √receiver height in feet.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of new LO in 062 02 01 03 (01)
062 02 03 04		***Errors and accuracy***								
(01)		Define 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 as within half-full scale deflection of the required track.	X	X	X	X	X	X	X	
(02)		State that due to reflections from terrain, radials can be bent and lead to wrong or fluctuating indications, which is called ‘scalloping’.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~LO (03)~~		~~State that DVOR is less sensitive to site error than CVOR.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
062 02 04 00		**Distance-measuring equipment (DME)**								
062 02 04 01		***Principles***								
(01)		State that DME operates in the UHF band ~~between 960 – 1215 MHz according to ICAO Annex 10~~.	X	X	X	X	X	X	X	Figures are not relevant for practical use
(02)	X	State that the system comprises two basic components: — the aircraft component~~,~~: the interrogator; — the ground component~~,~~: the transponder.	X	X	X	X	X	X	X	
(03)		Describe the principle of distance measurement using DME in terms of a timed transmission from the interrogator and reply from the transponder.~~:~~ ~~— pulse pairs~~ ~~— fixed frequency division of 63 MHz;~~ ~~— propagation delay;~~ ~~— 50-microsecond delay time;~~ ~~— irregular transmission sequence;~~ ~~— search mode;~~ ~~— tracking mode;~~ — ~~memory mode.~~	X	X	X	X	X	X		Not relevant anymore for modern digital DMEs LO adjusted for practical use

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(04)		State that the distance measured by DME is slant range.	X	X	X	X	X	X	X	
(05)		Illustrate that a position line using DME is a circle with the station at its centre.	X	X	X	X	X	X	X	
(06)		~~Describe how~~ State that the pairing of VHF and UHF frequencies (VOR/DME) enables the selection of two items of navigation information from one frequency setting.	X	X	X	X	X	X	X	LO level too detailed
(07)	X	Describe, in the case of co-location, the frequency pairing and identification procedure.	X	X	X	X	X	X	X	
~~LO (08)~~		~~Explain that depending on the configuration, the combination of a DME distance with a VOR radial can determine the position of the aircraft.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of old 061 03 03 01
(09)		~~Explain~~ State that military UHF tactical air navigation aid (TACAN) stations may be used for DME information.	X	X	X	X	X	X	X	LO level too detailed
062 02 04 02		**Presentation and interpretation**								
(01)	X	~~Explain~~ 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~~s~~ itself approximately every 40 seconds.	X	X	X	X	X	X	X	LO level too detailed
(02)		Calculate ground distance from given slant range and altitude.	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(03)		Describe the use of DME to fly a DME arc in accordance with ICAO Doc 8168, Volume 1.	X	X	X	X	X	X	X	
(04)	X	State that a DME system may have a ground speed read-out combined with the DME read-out.	X	X	X	X	X	X	X	
062 02 04 03		***Coverage and range***								
~~LO (01)~~		~~Explain why a ground station can generally respond to a maximum of 100 aircraft.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use
~~LO (02)~~		~~Explain which aircraft will be denied a DME range first when more than 100 interrogations are being made.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use
062 02 04 04		~~***Errors and accuracy***~~ ***Intentionally left blank***								
~~LO (01)~~		~~State that the error of the DME 'N' according to ICAO Annex 10 should not exceed ± 0.25 NM + 1.25 % of the distance measured.~~ ~~For installations installed after 1 January 1989, the total system error should not exceed 0.2 NM DME 'P'.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		ICAO Annex 10 does not state the total system error
062 02 04 05		***Factors affecting range and accuracy***								
~~LO (01)~~		~~State that the ground speed read-out combined with DME is only correct when tracking directly to or from the DME station.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of 062 02 04 05 02
(02)		~~State~~ Explain why ~~that, close to the station,~~ the ground speed read-out ~~commbined with~~ from a DME ~~is~~ can be	X	X	X	X	X	X	X	Rephrased

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		less than the actual ground speed and is zero when flying a DME arc.								
062 02 05 00		**Instrument landing system (ILS)**								
062 02 05 01		***Principles***								
(01)		Name the three main components of an ILS: — the localiser (~~LLZ~~LOC); — the glide path (GP); — range information (markers or DME).	X		X			X	X	
(02)	X	State the site locations of the ILS components: — the ~~localiser~~LOC antenna should be located on the extension of the runway centre line at the stop-end; — the ~~glide-path~~GP antenna should be located 300 m beyond the runway threshold, laterally displaced approximately 120 m to the side of the runway centre line.	X		X			X	X	
(03)		Explain that marker beacons produce radiation patterns to indicate predetermined distances from the threshold along the ILS ~~glide path~~GP.	X		X			X	X	
(04)		~~Explain~~ State that marker beacons are sometimes replaced by a DME paired with the ~~LLZ~~LOC frequency.	X		X			X	X	LO level too detailed

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(05)		State that in the ILS frequency assigned band 108.0–111.975 MHz, only frequencies which have an odd number in the first decimal are ILS frequencies.	X		X			X	X	
~~LO (06)~~		~~State that the LLZ operates in the 108.0–111.975 MHz VHF band, according to ICAO Annex 10.~~	~~X~~		~~X~~			~~X~~	~~X~~	Duplication of 062 02 05 01 05
(07)		State that the GP operates in the UHF band.	X		X			X	X	
(08)	X	Describe the use of the 90-Hz and the 150-Hz signals in the ~~LLZ~~LOC and GP transmitters/receivers, stating how the signals at the receivers vary with angular deviation.	X		X			X	X	
~~LO (09)~~		~~Draw the radiation pattern with respect to the 90-Hz and 150-Hz signals.~~	~~X~~		~~X~~			~~X~~		No practical use
(10)		~~Explain how~~ State that the UHF ~~glide-path~~GP frequency is selected automatically by being paired with the ~~LLZ~~LOC frequency.	X		X			X		LO level adjusted for practical use
~~LO (11)~~		~~Explain the term 'Difference of Depth of Modulation (DDM)'.~~	~~X~~		~~X~~			~~X~~		No practical use
~~LO (12)~~		~~State that the difference in the modulation depth increases with displacement from the centre line.~~	~~X~~		~~X~~			~~X~~		No practical use
(13)		~~State~~ Explain that both the ~~LLZ~~LOC and the GP antenna radiates side lobes (false beams) which can give rise to false centre-line and false ~~glide-path~~GP indication.	X		X			X	X	LO level adjusted for understanding

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(14)	X	Explain that the back beam from the ~~LLZ~~LOC antenna may be used as a published 'non-precision approach'.	X		X			X	X	
(15)		State that ~~according ICAO Annex 10~~ the ~~nominal~~ recommended ~~glide path~~GP is 3°.	X		X			X	X	ICAO Annex 10
(16)		Name the frequency, modulation and identification assigned to all marker beacons ~~according to ICAO Annex 10:~~. All marker beacons operate on 75-MHz carrier frequency. The modulation frequencies of the audio are: — outer marker: ~~400 Hz~~ low; — middle marker: ~~1 300 Hz~~ medium; — inner marker: ~~3 000 Hz~~ 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.	X		X			X		ICAO Annex 10 Figures of modulation frequencies are not important. Combined with 062 02 05 02 (05)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(17)		State that ~~according to ICAO Doc 8168~~ the final-approach area contains a fix or facility that permits verification of the ILS ~~glide path~~GP ~~–~~altimeter relationship. The outer marker or DME is usually used for this purpose.	X		X			X		ICAO Doc 8168
062 02 05 02		***Presentation and interpretation***								
(01)		Describe the ILS identification regarding frequency and Morse code and/or plain text.	X		X			X	X	
~~LO (02)~~		~~Calculate the rate of descent for a 3°-glide-path angle given the ground speed of the aircraft and using the formula:~~ ~~Rate of Descent (ROD) in ft/min = (ground speed in kt × 10) / 2.~~	~~X~~		~~X~~			~~X~~	~~X~~	Shift to 033
~~LO (03)~~		~~Calculate the rate of descent using the following formula when flying any glide-path angle:~~ ~~ROD ft/min = *Speed Factor (SF)* × glide-path angle × 100.~~	~~X~~		~~X~~			~~X~~	~~X~~	Rule of thumb not generally in use
~~LO (04)~~		~~Interpret the markers by sound, modulation, and frequency.~~	~~X~~		~~X~~			~~X~~	~~X~~	Duplication of 062 02 05 01 16
~~LO (05)~~		~~State that the outer-marker cockpit indicator is coloured blue, the middle marker amber, and the inner marker white.~~	~~X~~		~~X~~			~~X~~	~~X~~	Combined with 062 02 05 01 16
(06)		State that ~~according ICAO Annex 10~~ an ILS installation has	X		X			X		ICAO Annex 10

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		an automatic ground monitoring system.								
(07)		State that the ~~LLZ~~LOC and GP monitoring system monitors any shift in the ~~LLZ~~LOC and GP mean course line or reduction in signal strength.	X		X			X		
(08)		State that a failure of either the ~~LLZ~~LOC or the GP to stay within the predetermined limits will cause: — removal of identification and navigation components from the carrier; — radiation to cease; — a warning to be displayed at the designated control point.	X		X			X	X	
~~LO (09)~~		~~State that an ILS receiver has an automatic monitoring function.~~	~~X~~		~~X~~			~~X~~	~~X~~	Irrelevant
(10)		Describe the circumstances in which warning flags will appear for both the ~~LLZ~~LOC and the GP: — absence of the carrier frequency; — absence of the ~~90 and 150 Hz nav~~ modulation simultaneously; — the percentage modulation of ~~either~~ the ~~90 or 150 Hz~~ navigation signal reduced to 0.	X		X			X		Figures are not important for practical use
(11)		Interpret the indications on a ~~Course Deviation Indicator~~	X		X			X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~(~~CDI~~)~~ and an ~~Horizontal Situation Indicator (~~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.								
(12)		Interpret the aircraft's position in relation to the extended runway centre line on a back-beam approach.	X		X			X	X	
(13)		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.	X		X			X	X	OBI and reversed indications included
062 02 05 03		***Coverage and range***								
(01)		Sketch the standard coverage area of the ~~LLZ~~LOC and GP with angular sector limits in degrees and distance limits from the transmitter: — ~~LLZ~~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.	X		X			X	X	See ICAO Annex 10 Deleted part is duplication of 062 02 02 01 (07)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~– Define a 'locator beacon' as an LF/MF NDB used as an aid to final approach usually with a range, according to ICAO Annex 10, of 10–25 NM.~~								
062 02 05 04		***Errors and accuracy***								
(01)		Explain that ILS approaches are divided into facility performance categories defined in ICAO Annex 10.	X		X			X	X	
(02)		Define the following ILS operation categories: — Category I; — Category II; — Category IIIA; — Category IIIB; — Category IIIC.	X		X			X		
(03)		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.	X		X			X		
(04)		Explain why the accuracy requirements are progressively higher for CAT I, CAT II and CAT III ILS.	X		X			X		
~~LO (05)~~		~~State the vertical-accuracy requirements above the threshold for CAT I, II and III for the signals of the ILS ground installation.~~	~~X~~		~~X~~			~~X~~		Figures have to be looked up and not learned by heart
(06)		Explain the following in accordance with ICAO Doc 8168:	X		X			X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		— the accuracy the pilot has to fly the ILS ~~localiser~~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 ~~LLZ~~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.								
(07)		State that if a pilot deviates by more than half-scale deflection on the ~~LLZ~~LOC or by more than half-dot ~~course fly up~~ deflection on the GP, an immediate missed approach should be executed because obstacle clearance may no longer be guaranteed.	X		X			X	X	Also, deviation outside half scale will violate the normal stabilisation criteria and this includes above GP too
(08)		Describe ILS beam bends as ~~. D~~deviations from the nominal ~~position of the LLZ~~LOC and GP respectively and these can be assessed~~. They are ascertained~~ by flight test.	X		X			X		
(09)		Explain that multipath interference is caused by ~~.~~ ~~R~~reflections from ~~large~~ objects within the ILS coverage area.	X		X			X		
062 02 05 05		***Factors affecting range and accuracy***								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(01)		Define the 'ILS-critical area': an area of defined dimensions about the ~~LLZ~~LOC and GP antennas where vehicles, including aircraft, are excluded during all ILS operations.	X		X			X		
(02)		Define the 'ILS-sensitive area': an area extending beyond the critical area where the parking and/or movement of vehicles, including aircraft, is controlled to prevent the possibility of unacceptable interference to the ILS signal during ILS operations.	X		X			X		
~~LO (03)~~		~~Describe the effect of FM broadcast stations that transmit on frequencies just below 108 MHz.~~	X		X			X		All receivers have FM immune filters
062 02 06 00		~~**Microwave Landing System (MLS)**~~ **Intentionally left blank**								No practical application, GNSS approaches are developed
~~***062 02 06 01***~~		~~***Principles***~~								
~~LO (01)~~		~~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~~	~~X~~		~~X~~			~~X~~		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~system and the approach conditions.~~								
~~LO (02)~~		~~State that MLS operates in the S band on 200 channels.~~	~~X~~		~~X~~			~~X~~		
~~LO (03)~~		~~Explain the reason why MLS can be installed at airports on which, as a result of the effects of surrounding buildings and/or terrain, ILS siting is difficult.~~	~~X~~		~~X~~			~~X~~		
~~***062 02 06 02***~~		~~***Presentation and interpretation***~~								
~~LO (01)~~		~~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.~~	~~X~~		~~X~~			~~X~~		
~~LO (02)~~		~~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.~~	~~X~~		~~X~~			~~X~~		
~~LO (03)~~		~~Illustrate that segmented and curved approaches can only be executed with DME P installed.~~	~~X~~		~~X~~			~~X~~		
~~LO (04)~~		~~Explain why aircraft are equipped with a Multimode Receiver (MMR) in order to be able to receive ILS, MLS and GPS.~~	~~X~~		~~X~~			~~X~~		
~~LO (05)~~		~~Explain why MLS without DME P gives an ILS lookalike straight-line approach.~~	~~X~~		~~X~~			~~X~~		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~***062 02 06 03***~~		~~***Coverage and range***~~								
~~LO (01)~~		~~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).~~	~~X~~		~~X~~			~~X~~		
~~***062 02 06 04***~~		~~***Error and accuracy***~~								
~~LO (01)~~		~~State the 95 % lateral and vertical accuracy within 20 NM (37 km) of the MLS approach reference datum and 60 ft above the MLS datum point (according to ICAO Annex 10).~~	~~X~~		~~X~~			~~X~~		
062 03 00 00		**RADAR**								
062 03 01 00		**Pulse techniques and associated terms**								
(01)		Name the different applications of radar with respect to air traffic control (ATC), MET observations, and airborne weather radar (AWR).	X	X	X	X	X	X	X	
(02)	X	Describe the pulse technique and echo principle on which primary radar systems are based.	X	X	X	X	X	X		
(03)	X	~~Explain the relationship between the maximum theoretical range and the Pulse Repetition Frequency (PRF)~~ State that the maximum range of a radar depends on pulse repetition frequency (PRF), power, height of	X	X	X	X	X	X		Summarisation and generalisation of the following LOs: 062 03 01 00 (04) to (07)

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		aircraft, and radar antenna and frequency used.								
~~LO (04)~~		~~Calculate the maximum theoretical unambiguous range if the PRF is given using the formula:~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (05)~~		~~Calculate the PRF if the maximum theoretical unambiguous range of the radar is given using the formula:~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (06)~~		~~Explain that pulse length defines the minimum theoretical range of a radar.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (07)~~		~~Explain the need to harmonise the rotation speed of the antenna, the pulse length and the pulse repetition frequency for range.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(08)	X	Describe, in general terms, the effects of the following factors with respect to the quality of the target depiction on the radar display: — super-refraction and sub-refraction; — attenuation with distance; — condition and size of the reflecting surface.	X	X	X	X	X	X	X	
062 03 02 00		**Ground radar**								
062 03 02 01		***Principles***								
(01)		Explain that primary radar provides bearing and distance of targets.	X		X	X		X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(02)	X	Explain that primary ground radar is used to detect aircraft that are not equipped with a secondary radar transponder.	X		X	X		X	X	
~~LO (03)~~		~~Explain why Moving Target Indicator (MTI) is used.~~	~~X~~		~~X~~	~~X~~		~~X~~	~~X~~	No practical use
~~***062 03 02 02***~~		~~***Presentation and interpretation***~~								
~~LO (01)~~		~~State that modern ATC systems use computer generated display.~~	~~X~~		~~X~~	~~X~~		~~X~~	~~X~~	No practical use
~~LO (02)~~		~~Explain that the radar display enables the ATS controller to provide information, surveillance or guidance service.~~	~~X~~		~~X~~	~~X~~		~~X~~	~~X~~	No explanation necessary
062 03 03 00		**Airborne weather radar**								
062 03 03 01		***Principles***								
(01)		List the two main tasks of the weather radar in respect of weather and navigation.	X		X	X		X	X	
~~LO (02)~~		~~State the wavelength (approx. 3 cm) and frequency of most AWRs (approx. 9 GHz).~~	~~X~~		~~X~~	~~X~~		~~X~~		No practical use
(03)	X	Explain how the antenna is attitude-stabilised in relation to the horizontal plane using the aircraft's attitude reference system.	X		X	X		X	X	
~~LO (04)~~		~~Explain that older AWRs have two different radiation patterns which can be produced by a single antenna, one for mapping (cosecant squared) and the other for~~	~~X~~		~~X~~	~~X~~		~~X~~		Outdated

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~weather (pencil/cone-shaped).~~								
(05)	X	Describe the cone-shaped pencil beam of about 3~~°~~ to 5° beam width used for weather depiction.	X		X	X		X	X	
~~LO (06)~~		~~Explain that in modern AWRs a single radiation pattern is used for both mapping and weather with the scanning angle being changed between them.~~	~~X~~		~~X~~	~~X~~		~~X~~	~~X~~	Too basic
062 03 03 02		***Presentation and interpretation***								
(01)		Explain the functions of the following different modes 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.	X		X	X		X	X	
~~LO (02)~~		~~Name, for areas of differing reflection intensity, the colour gradations (green, yellow, red and magenta) indicating the increasing intensity of precipitation.~~	~~X~~		~~X~~	~~X~~		~~X~~	~~X~~	Duplication of 050 10 01 04 (06)
(03)	X	Illustrate the use of azimuth-marker lines and range lines in respect of the relative bearing and the distance to a thunderstorm or to a landmark on the screen.	X		X	X		X	X	
062 03 03 03		***Coverage and range***								
(01)		Explain how the radar is used for weather detection and	X		X	X		X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		for mapping (range, tilt and gain, if available).								
062 03 03 04		***Errors, accuracy, limitations***								
(01)		Explain why AWR should be used with extreme caution when on the ground.	X		X	X		X	X	
062 03 03 05		***Factors affecting range and accuracy***								
(01)		Explain the danger of the area behind heavy rain (shadow area) where no radar waves will penetrate.	X		X	X		X	X	
(02)		Describe appropriate tilt settings in relation to altitude and thunderstorms.	X		X	X		X	X	
~~LO (03)~~		~~Explain why the tilt setting should be lower when the aircraft climbs to a higher altitude.~~	X		X	X		X	X	Duplication of 062 03 03 05 (02)
(04)		Explain why a thunderstorm may not be detected when the tilt is set too high.	X		X	X		X	X	
~~***062 03 03 06***~~		~~***Application for navigation***~~								
~~LO (01)~~		~~Describe the navigation function of the radar in the mapping mode.~~	~~X~~		~~X~~	~~X~~		~~X~~	~~X~~	No practical use
~~LO (02)~~		~~Describe the use of the weather radar to avoid a thunderstorm (Cb).~~	~~X~~		~~X~~	~~X~~		~~X~~	~~X~~	Duplication of 050 10 01 04 (07)
~~LO (03)~~		~~Explain how turbulence (not CAT) can be detected by a~~	~~X~~		~~X~~	~~X~~		~~X~~	~~X~~	Transferred to

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~modern weather radar.~~								050 10 01 04 (08)
~~LO (04)~~		~~Explain how windshear can be detected by a modern weather radar.~~	~~X~~		~~X~~	~~X~~		~~X~~	~~X~~	Transferred to 050 10 01 04 (09)
062 03 04 00		**Secondary surveillance radar and transponder**								
062 03 04 01		***Principles***								
(01)		~~Explain~~ State that the ~~Air Traffic Control (~~ATC~~)~~ system is based on the replies provided by the airborne transponders in response to interrogations from the ATC secondary radar.	X	X	X	X	X	X	X	Too detailed
(02)	X	~~Explain~~ State that the ground ATC secondary radar uses techniques which provide the ATC with information that cannot be acquired by the primary radar.	X	X	X	X	X	X	X	Too high LO level
(03)	X	~~Explain~~ 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).	X	X	X	X	X	X	X	Too high LO level
(04)		~~Explain~~ State the advantages of secondary surveillance radar (SSR) over a primary radar regarding range and collected information.	X	X	X	X	X	X	X	Too high LO level and LO clarified
062 03 04 02		***Modes and codes***								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(01)	X	~~Explain~~ State that the interrogator transmits its interrogations in the form of a series of pulses.	X	X	X	X	X	X	X	Too high LO level
(02)		Name ~~and explain~~ the interrogation modes: — Mode A and C; — ~~Intermode:~~ • ~~Mode A/C/S all call,~~ • ~~Mode A/C only all call;~~ — Mode S~~:~~. • ~~Mode S only all call,~~ • ~~broadcast (no reply elicited),~~ • ~~selective.~~	X	X	X	X	X	X	X	Too high LO level
~~LO (03)~~		~~State that the interrogation frequency is 1 030 MHz and the reply frequency is 1 090 MHz.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~			Figures are not important for practical use
(04)		Explain that the decoding of the time between the interrogation pulses determines the operating mode of the transponder: — Mode A: transmission of aircraft transponder code; — Mode C: transmission of aircraft pressure altitude; — Mode S: aircraft selection and transmission of flight data for the ground surveillance.	X	X	X	X	X			
~~LO (05)~~		~~State that the ground interrogation signal is transmitted~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~			Too detailed

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~in the form of pairs of pulses P1 and P3 for Mode A and C, and that a control pulse P2 is transmitted following the first interrogation pulse P1.~~								technical information
~~LO (06)~~		~~Explain that the interval between P1 and P3 determines the mode of interrogation, Mode A or C.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~			Too detailed technical information
~~LO (07)~~		~~State that the radiated amplitude of P2 from the side lobes and from the main lobe is different.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~			Too detailed technical information
~~LO (08)~~		~~State that Mode-A designation is a sequence of four digits which can be manually selected from 4 096 available codes.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Irrelevant
(09)		State that in Mode C reply the pressure altitude is reported in 100-ft increments.	X	X	X	X	X	X		
(10)		~~Explain~~ State that in addition to the information ~~pulses~~ provided, a s~~S~~pecial p~~P~~osition i~~I~~dentification (SPI) pulse can be transmitted but only as a result of a manual selection (IDENT).	X	X	X	X	X	X		Too high LO level
(11)	X	State the need for compatibility of Mode S with Mode A and C.	X	X	X	X	X	X		
(12)		Explain that Mode S transponders receive interrogations from other Mode S transponders and SSR ground stations.	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(13)	X	State that Mode S surveillance protocols implicitly use the principle of selective addressing.	X	X	X	X	X	X		
(14)	X	~~Explain~~ State that every aircraft will have been allocated an ICAO a~~A~~ircraft a~~A~~ddress which is hard-coded into the ~~airframe~~ Mode S transponder (Mode S address).	X	X	X	X	X	X	X	Too high LO level and wording corrected
~~LO (15)~~		~~Explain that the ICAO Aircraft Address consists of 24 bits (therefore more than 16 000 000 possible codes) allocated by the registering authority of the State in which the aircraft is registered.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (16)~~		~~Explain that this (24-bit) address is included in all Mode S transmissions, so that every interrogation can be directed to a specific aircraft, preventing multiple replies.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Too detailed technical information
~~LO (17)~~		~~State that the ground interrogation signal is transmitted in the form of P1, P3 and P4 pulses for Mode S.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Too detailed technical information
(18)	X	Interpret the following Mode S terms: — selective addressing; — mode 'all call'; — selective call.	X	X	X	X	X	X	X	
(19)	X	State that Mode S interrogation contains either: — aircraft address; — all-call address;	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		— broadcast address.								
~~LO (20)~~		~~Mode A/C/S all-call consists of 3 pulses: P1, P3 and the long P4. A control pulse P2 is transmitted following P1 to suppress responses from aircraft in the side lobes of the interrogation antenna.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (21)~~		~~Mode A/C only all-call consists of 3 pulses: P1, P3 and the short P4.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Too detailed technical information
~~LO (22)~~		~~State that there are 25 possible Mode S reply forms.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Too detailed technical information
~~LO (23)~~		~~State that the reply message consists of a preamble and a data block.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Too detailed technical information
~~LO (24)~~		~~State that the Aircraft Address shall be transmitted in any reply except in Mode S only all-call reply.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Too basic
(25)		Explain that Mode S can provide enhanced vertical tracking, using a 25-feet altitude increment.	X	X	X	X	X	X		
(26)		~~Explain how~~ State that SSR can be used for automatic dependent surveillance — broadcast (ADS-B).	X	X	X	X	X	X		Too high LO level
062 03 04 03		***Presentation and interpretation***								
(01)		State that an aircraft can be identified by a unique code.	X	X	X	X	X	X	X	
(02)		~~Illustrate how~~ State which ~~the following~~ information ~~is~~ can be presented on the ATS display system ~~radar~~	X	X	X	X	X	X	X	LO level adjusted for practical use

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~screen:~~. ~~— pressure altitude;~~ ~~— flight level;~~ ~~— flight number or aircraft registration;~~ ~~— ground speed.~~								
(03)		~~Name and interpret the codes 7700, 7600 and 7500.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Duplication of 010 06 08 01 (05) and 091 04 00 00
(04)	X	Interpret the selector modes: OFF, Standby, ON (mode A), ALT (mode A and C), and TEST.	X	X	X	X	X	X	X	
~~LO (05)~~		~~Explain the function of the emission of a Special Position Identification (SPI) pulse after pushing the IDENT button in the aircraft.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Too detailed technical information
		ELEMENTARY SURVEILLANCE								
(06)		Explain that the elementary surveillance provides the ATC controller with the aircraft's position, altitude and identification.	X	X	X	X	X	X	X	
(07)		State that the elementary surveillance needs Mode S transponders with s~~S~~urveillance i~~I~~dentifier (SI) code capacity and the automatic reporting of aircraft identification~~, known as ICAO Level 2s~~.	X	X	X	X	X	X	X	Irrelevant to mention Level 2s

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(08)		State that the SI code must correspond to the aircraft identification specified in item 7 of the ICAO flight plan or to the registration mark~~ing~~.	X	X	X	X	X	X	X	
(09)		State that only the ICAO identification format is compatible with the ATS ground system.	X	X	X	X	X	X		
~~LO (10)~~		~~State that Mode S equipped aircraft with a maximum mass in excess of 5 700 kg or a maximum cruising true airspeed capability in excess of 250 kt must operate with transponder antenna diversity.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Irrelevant
~~LO (11)~~		~~Describe the different types of communication protocols (A, B, C and D).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Irrelevant
~~LO (12)~~		~~Explain that elementary surveillance is based on Ground-Initiated Comm-B protocols.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Irrelevant
		ENHANCED SURVEILLANCE								
(13)		State that enhanced surveillance consists of the extraction of additional aircraft parameters known as d~~D~~ownlink a~~A~~ircraft p~~P~~arameters (DAP) consisting of: — magnetic heading; — indicated airspeed; — Mach number; — vertical rate;	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		— roll angle; — track angle rate; — true track angle; — ground speed; — selected altitude.								
(14)		Explain that the ATC controller's information is improved by providing actual aircraft-derived data such as magnetic heading, indicated airspeed, vertical rate and selected altitude.	X	X	X	X	X	X		
(15)		Explain that the automatic extraction of an aircraft's parameters, and their presentation to the ATC controller, will reduce ~~their R/T workload and will free them to concentrate on ensuring the safe and efficient passage of air traffic~~ the likelihood of pilots mis-selecting speed, heading and/or altitude.	X	X	X	X	X	X		LO adjusted for practical use Incorporates 062 03 04 03 (16)
~~LO (16)~~		~~Explain that the reduction in radio-telephony between the air traffic controllers and the pilots will reduce pilot workload and remove a potential source of error.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Combined with 062 03 04 03 15
~~***062 03 04 04***~~		~~***Errors and accuracy***~~								
~~LO (01)~~		~~Explain the following disadvantages of SSR (Mode A/C):~~ ~~— code garbling of aircraft less than 1.7 NM apart measured in the vertical plane perpendicular to~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Outdated and irrelevant

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~and from the antenna; .~~ — ~~'fruiting' which results from the reception of replies caused by interrogations from other radar stations.~~								
062 04 00 00		**INTENTIONALLY LEFT BLANK**								
062 05 00 00		~~**AREA NAVIGATION SYSTEMS, RNAV/FMS**~~								
~~**062 05 01 00**~~		~~**General philosophy and definitions**~~								All LOs under **062 05 01** are deleted and replaced with the PBN LOs (062 07)
~~***062 05 01 01***~~		~~***Basic RNAV (B-RNAV), Precision RNAV (P-RNAV), RNP PNAV***~~								
~~LO~~		~~Define 'Area Navigation' (RNAV) (ICAO Annex 11). A method of navigation permitting aircraft operations on any desired track within the coverage of station referenced navigation signals, or within the limits of a self-contained navigation system.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO~~		~~State that Basic RNAV (B-RNAV) systems require RNP 5.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO~~		~~State that Precision RNAV (PRNAV) systems require RNP 1.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~***062 05 01 02***~~		~~***Principles of 2D RNAV, 3D RNAV and 4D RNAV***~~								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~LO~~		~~State that a 2D RNAV system is able to navigate in the horizontal plane only.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO~~		~~State that a 3D RNAV system is able to navigate in the horizontal plane and in addition has a guidance capability in the vertical plane.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO~~		~~State that a 4D RNAV system is able to navigate in the horizontal plane, has a guidance capability in the vertical plane and in addition has a timing function.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~***062 05 01 03***~~		~~***Required Navigation Performance (RNP) in accordance with ICAO Doc 9613***~~								
~~LO~~		~~State that RNP is a concept that applies to navigation performance within an airspace.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO~~		~~The RNP type is based on the navigation performance accuracy to be achieved within anairspace.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO~~		~~State that RNP X requires a navigation performance accuracy of ± X NM both lateral and longitudinal 95 % of the flying time (RNP 1 requires a navigation performance of ± 1 NM both lateral and longitudinal 95 % of the flying time).~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO~~		~~State that RNAV equipment is one requirement in order to receive approval to operate in an RNP environment.~~	~~X~~		~~X~~			~~X~~	~~X~~	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~LO~~		~~State that RNAV equipment operates by automatically determining the aircraft's position.~~	~~X~~		~~X~~			~~X~~		
~~LO~~		~~State that the following are output data from a 4D-RNAV system:~~ ~~— distance to any waypoint;~~ ~~— estimated time overhead;~~ ~~— ground speed and TAS;~~ ~~— true wind;~~ ~~— track error.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO~~		~~Flight Management System (FMS) and general terms.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO~~		~~Navigation and flight management.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO~~		~~Explain that the development of computers which combine reliable liquid crystal displays offer the means of accessing more data and displaying them to the flight crew.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO~~		~~Explain that a flight management system has the ability to monitor and direct both navigation and performance of the flight.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~**062 05 02 00**~~		~~**Simple 2D RNAV**~~ ~~*Info: First generation of radio-navigation systems*~~								All LOs under **062 05 02** are deleted and replaced with the PBN LOs

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~*allowing the flight crew to select a phantom waypoint on the RNAV panel and select a desired track to fly inbound to the waypoint.*~~								(062 07)
~~***062 05 02 01***~~		~~***Flight-deck equipment***~~								
~~LO~~		~~The control unit allows the flight crew to:~~ ~~— tune the VOR/DME station used to define the phantom waypoint;~~ ~~— define the phantom waypoint as a radial and distance (DME) from the selected VOR/DME station;~~ ~~— select the desired magnetic track to follow inbound to the phantom waypoint;~~ ~~— select between an en route mode, an approach mode of operation and the basic VOR/DME mode of operation.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO~~		~~Track guidance is shown on the HSI/CDI.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~**062 05 02 02**~~		~~Navigation computer, VOR/DME navigation~~								
~~LO~~		~~The navigation computer of the simple 2D-RNAV system computes the navigational problems by simple sine and cosine mathematics, solving the triangular problems.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~**062 05 02 03**~~		~~Navigation computer input/output~~								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~LO~~		~~State that the following input data to the navigation computer is:~~ ~~— the actual VOR radial and DME distance from the selected VOR station;~~ ~~— the radial and distance to phantom waypoint;~~ ~~— the desired magnetic track inbound to the phantom waypoint.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO~~		~~State the following output data from the navigation computer:~~ ~~— desired magnetic track to the phantom waypoint shown on the CDI at the course pointer;~~ ~~— distance from the present position to the phantom waypoint;~~ ~~— deviations from the desired track as follows:~~ ~~• in en route mode, full-scale deflection on the CDI is 5 NM;~~ ~~• in approach mode, full-scale deflection on the CDI is 1 ¼ NM;~~ ~~• in VOR/DME mode, full-scale deflection on the CDI is 10°.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO~~		~~State that the system is limited to operate within the range of the selected VOR/DME station.~~	~~X~~		~~X~~			~~X~~	~~X~~	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~**062 05 03 00**~~		~~**4D RNAV**~~ ~~*Info: The next generation of area navigation equipment allowed the flight crew to navigate on any desired track within the coverage of VOR/DME stations.*~~								All LOs under **062 05 03** are deleted and replaced with the PBN LOs (062 07)
~~***062 05 03 01***~~		~~***Flight deck equipment***~~								
~~LO~~		~~State that in order to give the flight crew control over the required lateral guidance functions, RNAV equipment should at least be able to perform the following functions:~~ ~~— display present position in latitude/ longitude or as distance/bearing to the selected waypoint;~~ ~~— select or enter the required flight plan through the Control and Display Unit (CDU);~~ ~~— review and modify navigation data for any part of a flight plan at any stage of flight and store sufficient data to carry out the active flight plan;~~ ~~— review, assemble, modify or verify a flight plan in flight, without affecting the guidance output;~~ ~~— execute a modified flight plan only after positive action by the flight crew;~~ ~~— where provided, assemble and verify an alternative flight plan without affecting the active flight plan;~~	~~X~~		~~X~~			~~X~~	~~X~~	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~— assemble a flight plan, either by identifier or by selection of individual waypoints from the database, or by creation of waypoints from the database, or by creation of waypoints defined by latitude/longitude, bearing/distance parameters or other parameters;~~ ~~— assemble flight plans by joining routes or route segments;~~ ~~— allow verification or adjustment of displayed position;~~ ~~— provide automatic sequencing through waypoints with turn anticipation; manual sequencing should also be provided to allow flight over, and return to, waypoints;~~ ~~— display cross-track error on the CDU;~~ ~~— provide time to waypoints on the CDU;~~ ~~— execute a direct clearance to any waypoint;~~ ~~— fly parallel tracks at the selected offset distance; offset mode should be clearly indicated;~~ ~~— purge previous radio updates;~~ ~~— carry out RNAV holding procedures (when defined);~~ ~~— make available to the flight crew estimates of~~								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~positional uncertainty, either as a quality factor or by reference to sensor differences from the computed position;~~ ~~— conform to WGS-84 geodetic reference system;~~ ~~— indicate navigation equipment failure.~~								
~~***062 05 03 02***~~		~~***Navigation computer, VOR/DME navigation***~~								
~~LO~~		~~State that the navigation computer uses signals from the VOR/DME stations to determine position.~~	~~X~~		~~X~~			~~X~~		
~~LO~~		~~Explain that the system automatically tunes the VOR/DME stations by selecting stations which provide the best angular fix determination.~~	~~X~~		~~X~~			~~X~~		
~~LO~~		~~Explain that the computer uses DME/DME to determine position if possible, and only if two DMEs are not available the system will use VOR/DME to determine the position of the aircraft.~~	~~X~~		~~X~~			~~X~~		
~~LO~~		~~Explain that the computer is navigating on the great circle between waypoints inserted into the system.~~	~~X~~		~~X~~			~~X~~		
~~LO~~		~~State that the system has a navigational database which may contain the following elements:~~ ~~— reference data for airports (4-letter ICAO identifier);~~	~~X~~		~~X~~			~~X~~		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~— VOR/DME station data (3-letter ICAO identifier);~~ ~~— waypoint data (5-letter ICAO identifier);~~ ~~— STAR data;~~ ~~— SID data;~~ ~~— airport runway data including thresholds and outer makers;~~ ~~— NDB stations (alphabetic ICAO identifier);~~ ~~— company flight-plan routes.~~								
~~LO~~		~~State that the navigational database is valid for a limited time, usually 28 days.~~	~~X~~		~~X~~			~~X~~		
~~LO~~		~~State that the navigational database is read only, but additional space exists so that crew-created navigational data may be saved in the computer memory. Such additional data will also be deleted at the 28-day navigational update of the database.~~	~~X~~		~~X~~			~~X~~		
~~LO~~		~~State that the computer receives a TAS input from the air-data computer and a heading input in order to calculate actual wind velocity.~~	~~X~~		~~X~~			~~X~~		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~LO~~		~~State that the computer calculates track error in relation to desired track. This data can easily be interfaced with the automatic flight control, and when done so, it enables the aircraft to automatically follow the flight plan loaded into the RNAV computer.~~	~~X~~		~~X~~			~~X~~		
~~LO~~		~~State that the computer is able to perform great-circle navigation when receiving VOR/DME stations. If out of range, the system reverts to DR (Dead Reckoning) mode, where it updates the position by means of last computed wind and TAS and heading information. Operation in DR mode is time-limited.~~	~~X~~		~~X~~			~~X~~		
~~LO~~		~~State that the system has 'direct to' capability to any waypoint.~~	~~X~~		~~X~~			~~X~~		
~~LO~~		~~State that the system is capable of parallel offset tracking.~~	~~X~~		~~X~~			~~X~~		
~~LO~~		~~State that any waypoint can be inserted into the computer in one of the following ways:~~ ~~— alphanumeric ICAO identifier;~~ ~~— latitude and longitude;~~ ~~— radial and distance from a VOR station.~~	~~X~~		~~X~~			~~X~~		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~**062 05 03 03**~~		~~***Navigation computer input/output***~~								
~~LO~~		~~State that the following are input data into a 4D-RNAV system:~~ ~~— DME distances from DME stations;~~ ~~— radial from a VOR station;~~ ~~— TAS and altitude from the air-data computer;~~ ~~heading from the aircraft's heading system.~~	~~X~~		~~X~~			~~X~~		
~~LO~~		~~State that the following are output data from a 4D-RNAV system:~~ ~~— distance to any waypoint;~~ ~~— estimated time overhead;~~ ~~— ground speed and TAS;~~ ~~— true wind;~~ ~~track error.~~	~~X~~		~~X~~			~~X~~		
~~**062 05 04 00**~~		~~**Flight Management System (FMS) and general terms**~~								Transferred to 022
~~***062 05 04 01***~~		~~***Navigation and flight management***~~								Transferred to 022
~~LO~~		~~Explain that the development of computers which combine reliable liquid crystal displays offer the means of accessing more data and displaying them to the flight crew.~~	~~X~~		~~X~~			~~X~~		Transferred to 022

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~LO~~		~~Explain that a flight management system has the ability to monitor and direct both navigation and performance of the flight.~~	~~X~~		~~X~~			~~X~~		Transferred to 022
~~LO~~		~~Explain the two functions common to all FMS systems:~~ ~~— automatic navigation Lateral Navigation (LNAV);~~ ~~— flight path management Vertical Navigation (VNAV).~~	~~X~~		~~X~~			~~X~~		Transferred to 022
~~LO~~		~~Name the main components of the FMS system as being:~~ ~~— Flight Management Computer (FMC);~~ ~~— Control and Display Unit (CDU);~~ ~~— Symbol generator~~ ~~— Electronic Flight Instrument System (EFIS) consisting of the NAV display, including mode selector and attitude display;~~ ~~— Auto-throttle (A/T) and Flight Control Computer (FCC).~~	~~X~~		~~X~~			~~X~~		Transferred to 022
~~***062 05 04 02***~~		~~***Flight management computer***~~								Transferred to 022
~~LO~~		~~State that the centre of the flight management system is the FMC with its stored navigation and performance data.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~***062 05 04 03***~~		~~***Navigation database***~~								Transferred to 022
~~LO~~		~~State that the navigation database of the FMC may~~	~~X~~		~~X~~			~~X~~	~~X~~	Transferred to 022

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~contain the following data:~~ ~~— reference data for airports (4 letter ICAO identifier);~~ ~~— VOR/DME station data (3 letter ICAO identifier);~~ ~~— waypoint data (5 letter ICAO identifier);~~ ~~— STAR data;~~ ~~— SID data;~~ ~~— holding patterns;~~ ~~— airport runway data;~~ ~~— NDB stations (alphabetic ICAO identifier);~~ ~~— company flight-plan routes.~~								
~~LO~~		~~State that the navigation database is updated every 28 days.~~	~~X~~		~~X~~			~~X~~	~~X~~	Transferred to 022
~~LO~~		~~State that the navigational database is write-protected, but additional space exists so that crew created navigational data may be saved in the computer's memory. Such additional data will also be deleted at the 28-day navigational update of the database.~~	~~X~~		~~X~~			~~X~~	~~X~~	Transferred to 022
~~***062 05 04 04***~~		~~***Performance database***~~								Transferred to 022
~~LO~~		~~State that the performance database stores all the data relating to the specific aircraft/engine configuration, and~~	~~X~~		~~X~~			~~X~~		Transferred to 022

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~is updated by ground staff when necessary.~~								
~~LO~~		~~State that the performance database of the FMC contain the following data:~~ ~~— V1, VR and V2 speeds;~~ ~~— aircraft drag;~~ ~~— engine-thrust characteristics;~~ ~~— maximum and optimum operating altitudes;~~ ~~— speeds for maximum and optimum climb;~~ ~~— speeds for long-range cruise, maximum endurance and holding;~~ ~~— maximum Zero Fuel Mass (ZFM), maximum Take-Off Mass (TOM) and maximum Landing Mass (LM);~~ ~~— fuel flow parameters;~~ ~~— aircraft flight envelope.~~	~~X~~		~~X~~			~~X~~		Transferred to 022
~~***062 05 04 05***~~		~~***Typical input/output data from the FMC***~~								Transferred to 022
~~LO~~		~~State the following are typical input data to the FMC:~~ ~~— time;~~ ~~— fuel flow;~~ ~~— total fuel;~~ ~~— TAS, altitude, vertical speed, Mach number and outside-air temperature from the Air-Data~~	~~X~~		~~X~~			~~X~~		Transferred to 022

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~Computer (ADC);~~ ~~— DME and radial information from the VHF/NAV receivers;~~ ~~— air/ground position;~~ ~~— flap/slat position;~~ ~~— IRS and GPS positions;~~ ~~Control and Display Unit (CDU) entries.~~								
~~LO~~		~~State that the following are typical output data from the FMC:~~ ~~— command signals to the flight directors and autopilot;~~ ~~— command signals to the auto-throttle;~~ ~~— information to the EFIS displays through the symbol generator;~~ ~~— data to the CDU and various annunciators.~~	~~X~~		~~X~~			~~X~~		Transferred to 022
~~***062 05 04 06***~~		~~***Determination of the FMS position of the aircraft***~~								Transferred to 022
~~LO~~		~~State that modern FMS may use a range of sensors for calculating the position of the aircraft including VOR, DME, GPS, IRS and ILS.~~	~~X~~		~~X~~			~~X~~	~~X~~	Transferred to 022
~~LO~~		~~State that the information from the sensors used may be blended into a single position by using a mathematic~~	~~X~~		~~X~~			~~X~~		Transferred to 022

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~algorithm.~~								
~~LO~~		~~State that the Kalman filter is an algorithm for filtering incomplete and noisy measurements of dynamical processes so that errors of measurements from different sensors are minimised, thus leading to the calculated position being more accurate than that produced by any single sensor.~~	~~X~~		~~X~~			~~X~~		
~~**062 05 05 00**~~		~~**Typical flight-deck equipment fitted on FMS aircraft**~~								Transferred to 022
~~***062 05 05 01***~~		~~***Control and Display Unit (CDU)***~~								Transferred to 022
~~LO~~		~~State that the communication link between the flight crew and the FMC is the CDU.~~	~~X~~		~~X~~			~~X~~		Transferred to 022
~~LO~~		~~Explain the main components of the CDU as follows:~~ ~~— CDU display including the following terms:~~ ~~• page title,~~ ~~• data field,~~ ~~• scratch pad;~~ ~~— line-select keys;~~ ~~— numeric keys;~~ ~~— alpha keys;~~ ~~— function and mode keys used to select specific data pages on the CDU display, to execute orders or to~~	~~X~~		~~X~~			~~X~~		Transferred to 022

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~navigate to pages through the data presented;~~ ~~warning lights, message light and offset light.~~								
~~***062 05 05 02***~~		~~***EFIS instruments (attitude display, navigation display)***~~								Transferred to 022
~~LO~~		~~State that FMS-equipped aircraft typically has two displays on the instrument panel in front of each pilot.~~	~~X~~		~~X~~			~~X~~		Transferred to 022
~~LO~~		~~State that the following data are typically displayed on the attitude display:~~ ~~— attitude information;~~ ~~— flight director command bars;~~ ~~— radio height and barometric altitude;~~ ~~— course deviation indication;~~ ~~— glide-path information (when an ILS is tuned);speed information.~~	~~X~~		~~X~~			~~X~~		Transferred to 022
~~***062 05 05 03***~~		~~***Typical modes of the navigation display***~~								Transferred to 022
~~LO~~		~~State the following typical modes of the navigation display:~~ ~~— full VOR/ILS mode showing the whole compass rose;~~ ~~— expanded (arc) VOR/ILS mode showing the forward 90° sector;~~ ~~— map mode;~~	~~X~~		~~X~~			~~X~~		Transferred to 022

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~— plan mode.~~								
~~***062 05 05 04***~~		~~***Typical information on the navigation display***~~								Transferred to 022
~~LO~~		~~List and interpret the following information typically shown on a navigation display in 'Full VOR/ILS' mode:~~ ~~— the map display will be in full VOR mode when a VOR frequency is selected, and full ILS mode when an ILS frequency is selected on the VHF NAV frequency selector;~~ ~~— DME distance to selected DME station;~~ ~~— a full 360° compass rose.~~ ~~At the top of the compass rose, present heading is indicated and shown as digital numbers in a heading box. Next to the heading box it is indicated whether the heading is true or magnetic. True heading is available on aircraft with IRS.~~ ~~A triangle (different symbols are used on different aircraft) on the compass rose indicates present track. Track indication is only available when the FMC navigation computer is able to compute the aircraft's position. A square symbol on the outside of the compass rose indicates the selected heading for the autopilot, and if 'heading select' mode is activated on the autopilot, this is the heading the aircraft will turn to.~~	~~X~~		~~X~~			~~X~~		Transferred to 022

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~Within the compass rose, a CDI is shown. On the CDI, the course pointer points to the selected VOR/ILS course SET on the OBS. On the CDI, the course deviation bar will indicate angular deflection from the selected VOR/ILS track. Full-scale deflection side to side in VOR mode is 20°, and 5° in ILS mode. In VOR mode, a TO/FROM indication is shown on the display.~~ ~~The selected ILS/VOR frequency is shown.~~ ~~ILS or VOR mode is shown according to the selected frequency.~~ ~~If an ILS frequency is selected, a glide path deviation scale is shown.~~ ~~A wind arrow indicating wind direction according to the compass rose, and velocity in numbers next to the arrow.~~								
~~LO~~		~~A wind arrow indicate wind direction according to the compass rose, and velocity in numbers next to the arrow.~~	~~X~~		~~X~~			~~X~~		Transferred to 022
~~LO~~		~~Given an EFIS navigation display in full VOR/ILS mode, read off the following information:~~ ~~— heading (magnetic/true);~~ ~~— track (magnetic/true);~~ ~~— drift;~~ ~~— wind correction angle;~~	~~X~~		~~X~~			~~X~~		Transferred to 022

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~— selected course;~~ ~~— actual radial;~~ ~~— left or right of selected track;~~ ~~— above or below the glide path;~~ ~~— distance to the DME station;~~ ~~— selected heading for the autopilot heading select bug;~~ ~~— determine whether the display is in VOR or ILS rose mode.~~								
~~LO~~		~~Given an EFIS navigation display in expanded VOR/ILS mode, read off the following information:~~ ~~— heading (magnetic/true);~~ ~~— track (magnetic/true);~~ ~~— drift;~~ ~~— wind correction angle;~~ ~~— tailwind/headwind;~~ ~~— wind velocity;~~ ~~— selected course;~~ ~~— actual radial;~~ ~~— left or right of selected track;~~ ~~— above or below the glide path;~~	~~X~~		~~X~~			~~X~~		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~— distance to the DME station;~~ ~~— selected heading for the autopilot heading select bug;~~ ~~— state whether the display is in VOR or ILS rose mode.~~								
~~LO~~		~~Given an EFIS navigation display in map mode, read off the following information:~~ ~~— heading (magnetic/true);~~ ~~— track (magnetic/true);~~ ~~— drift;~~ ~~— wind correction angle;~~ ~~— tailwind/headwind;~~ ~~— wind velocity;~~ ~~— left or right of the FMS track;~~ ~~— distance to active waypoint;~~ ~~— ETO next waypoint;~~ ~~— selected heading for the autopilot heading select bug;~~ ~~— determine whether a depicted symbol is a VOR/DME station or an airport;~~ ~~— determine whether a specific waypoint is part of~~	~~X~~		~~X~~			~~X~~		Transferred to 022

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~the FMS route.~~								
~~LO~~		~~Given an EFIS navigation display in plan mode, read off the following information:~~ ~~— heading (magnetic/true)~~ ~~— track (magnetic/true)~~ ~~— drift;~~ ~~— wind correction angle;~~ ~~— distance to active waypoint;~~ ~~— ETO active waypoint;~~ ~~— state the selected heading for the autopilot heading select bug;~~ ~~— measure and state true track of specific FMS route track.~~	~~X~~		~~X~~			~~X~~		Transferred to 022
062 06 00 00		**GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSSs)**								
062 06 01 00		**Global positioning system (GPS)~~, GLONASS, GALILEO~~**								
062 06 01 01		***Principles***								
(01)		State that there are ~~two~~ four main ~~Global Navigation Satellite Systems (~~GNSSs~~)~~. ~~currently in existence with a third one which is planned to be fully operational by 2011.~~ These are: — USA NAVigation System with Timing And Ranging	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		Global Positioning System (NAVSTAR GPS); — Russian GLObal NAvigation Satellite System (GLONASS); — European GALILEO (under construction);~~.~~ — Chinese BeiDou (under construction).								
(02)		State that all ~~three~~ four systems (will) consist of a constellation of satellites which can be used by a suitably equipped receiver to determine position.	X	X	X	X	X	X	X	Updated
062 06 01 02		***Operation***								
		~~NAVSTAR GPS~~ Global navigation satellite system (GNSS)								
~~LO (01)~~		~~State that there are currently two modes of operation: Standard Positioning Service (SPS) for civilian users, and Precise Positioning Service (PPS) for authorised users.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not relevant for civil aviation
~~LO (02)~~		~~SPS was originally designed to provide civilian users with a less accurate positioning capability than PPS.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Not relevant for civil aviation
(03)	X	Name the three segments as follows: — space segment; — control segment; — user segment.	X	X	X	X	X	X	X	
		Space segment								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(04)	X	State that the space segment consists of a notional constellation of 24 operational satellites.	X	X	X	X	X	X	X	
~~LO (05)~~	~~X~~	~~State that the space segment consists of a notional constellation of 24 operational satellites.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (06)~~	~~X~~	~~State that the satellites are orbiting the Earth in orbits inclined 55° to the plane of the equator.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (07)~~	~~X~~	~~State that the satellites are in a nearly circular orbit of the Earth at an altitude of 20 200 km (10 900 NM).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (08)~~	~~X~~	~~State that the satellites are distributed in 6 orbital planes with at least 4 satellites in each.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (09)~~		~~State that a satellite completes an orbit in approximately 12 hours.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(10)		State that each satellite broadcasts ranging signals on two UHF frequencies: L1 ~~1 575.42 MHz~~ and L2 ~~1 227.6 MHz~~.	X	X	X	X	X	X		Figures are not important for practical use
~~LO (11)~~		~~State that SPS is a positioning and timing service provided on frequency L1.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (12)~~		~~State that PPS uses both frequencies L1 and L2.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (13)~~		~~In 2005, the first replacement satellite was launched with a new military M-code on the L1 frequency, and a second signal for civilian use L2C on the L2 frequency.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(14)	X	State that the ranging signal contains a c~~C~~oarse a~~A~~cquisition (C/A) code and a navigational data message.	X	X	X	X	X	X		
(15)	X	State that the navigation message contains: — almanac data; — ephemeris; — satellite clock correction parameters; — Universal Time Coordinated (UTC) parameters; — ionospheric model; — satellite health data.	X	X	X	X	X	X		
~~LO (16)~~		~~State that it takes 12.5 minutes for a GPS receiver to receive all the data frames in the navigation message.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use
(17)		State that the almanac contains the orbital data about all the satellites in the GPS constellation.	X	X	X	X	X	X	X	
~~LO (18)~~		~~State that the ephemeris contains data used to correct the orbital data of the satellites due to small disturbances.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use
~~LO (19)~~		~~State that the clock correction parameters are data for the correction of the satellite time.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	No practical use
~~LO (20)~~		~~State that UTC parameters are factors determining the difference between GPS time and UTC.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Too detailed technical information

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(21)	X	State that an ionospheric model is currently used to calculate the time delay of the signal travelling through the ionosphere.	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	
~~LO (22)~~		~~State that the GPS health message is used to exclude unhealthy satellites from the position solution. Satellite health is determined by the validity of the navigation data.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Too detailed technical information
(23)	X	State that GPS uses the WGS-84 model.	X	X	X	X	X	X	X	
(24)	X	State that two codes are transmitted on the L1 frequency, namely a C/A code and a p~~P~~recision (P) code. The P code is not used for standard positioning service (SPS).	X	X	X	X	X	X		
~~LO (25)~~		~~State that the C/A code is a Pseudo Random Noise (PRN) code sequence, repeating every millisecond. Each C/A code is unique and provides the mechanism to identify each satellite.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (26)~~		~~State that satellites broadcast the PRN codes with reference to the satellite vehicle time which are subsequently changed by the receiver to UTC.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(27)	X	State that satellites are equipped with atomic clocks, which allow the system to keep very accurate time reference.	X	X	X	X	X	X	X	
		Control segment								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(28)	X	State that the control segment comprises: — a master control station; — ground antenna; — monitoring stations.	X	X	X	X	X	X	X	
(29)		~~State that the master control station is responsible for all aspects of the constellation command and control.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(30)		~~State that the main tasks of the control segment are:~~ ~~— managing SPS performance;~~ ~~— navigation data upload;~~ ~~monitoring satellites.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
		User segment								
(31)	X	State that GPS supplies three-dimensional position fixes and speed data, plus a precise time reference.	X	X	X	X	X	X	X	
~~LO (32)~~		~~State that the GPS receiver used in aviation is a multichannel type.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Too basic
(33)	X	State that a GPS 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.	X	X	X	X	X	X	X	
(34)	X	State that the initial distance calculated to the satellites is called pseudo-range because the difference between the	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		GPS receiver and the satellite time references initially creates an erroneous range.								
(35)	X	State that each range defines a sphere with its centre at the satellite.	X	X	X	X	X	X	X	
~~LO (36)~~		~~State that three satellites are needed to determine a two-dimensional position.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Irrelevant
(37)	X	State that four spheres are needed to calculate a three-dimensional position, hence four satellites are required.	X	X	X	X	X	X	X	
(38)	X	State that the GPS receiver is able to synchronise to the correct time base when receiving four satellites.	X	X	X	X	X	X	X	
(39)	X	State that the receiver is able to calculate aircraft ground speed using the space vehicle (SV) Doppler frequency shift and/or the change in receiver position over time.	X	X	X	X	X	X		
		NAVigation System with Timing And Ranging Global Positioning System (NAVSTAR GPS) integrity								
(40)		Define 'r~~R~~eceiver a~~A~~utonomous i~~I~~ntegrity m~~M~~onitoring (RAIM)': a technique whereby a receiver processor determines the integrity of the navigation signals.	X	X	X	X	X	X	X	
(41)		State that RAIM is achieved by consistency check among ~~pseudo-~~range measurements.	X	X	X	X	X	X	X	
(42)		State that basic RAIM requires five satellites. A sixth one	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		is for isolating a faulty satellite from the navigation solution.								
~~LO (43)~~		~~State that when a GPS receiver uses barometric altitude as an augmentation to RAIM, the number of satellites needed for the receiver to perform the RAIM function may be reduced by one.~~	X	X	X	X	X	X	X	
		GLOBAL NAVIGATION SATELLITE SYSTEM (GLONASS)								
~~LO (44)~~		~~List the three components of GLONASS:~~ ~~— space segment, which contains the constellation of satellites;~~ ~~— control segment, which contains the ground-based facilities;~~ ~~user segment, which contains the user equipment.~~	X	X	X	X	X	X		Too detailed information, no practical use
~~LO (45)~~		~~State the composition of the constellation in the 'space segment':~~ ~~— 24 satellites in 3 orbital planes with 8 equally displaced by 45° of latitude;~~ ~~— a near-circular orbit at 19 100 km at an inclination of 64.8° to the equator;~~ ~~each orbit is completed in 11 hours and 15 minutes.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(46)		State that the control segment provides:	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		— monitoring of the constellation status; — correction to orbital parameters; — navigation data uploading.								
~~LO (47)~~		~~State that the user equipment consists of receivers and processors for the navigation signals for the calculation of the coordinates, velocity and time.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (48)~~		~~State that the time reference is UTC.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (49)~~		~~State that the datum used is PZ-90 Earth-centred Earth-fixed.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (50)~~		~~State that each satellite transmits navigation signals on two frequencies of L-band, L1 1.6 GHz and L2 1.2 GHz. .~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Too detailed technical information
~~LO (51)~~		~~State that L1 is a standard-accuracy signal designed for civilian users worldwide and L2 is a high accuracy signal modulated by a special code for authorised users only. .~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (52)~~		~~State that the navigation message has a duration of 2 seconds and contains 'immediate' data which relates to the actual satellite transmitting the given navigation signal and 'non-immediate' data which rel. ates to all other satellites within the constellation.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~LO (53)~~		~~State that 'immediate data' consists of:~~ ~~— enumeration of the satellite time marks;~~ ~~— difference between onboard time scale of the satellite and GLONASS time;~~ ~~— relative differences between carrier frequency of the satellite and its nominal value;~~ ~~— ephemeris parameters.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (54)~~		~~State that 'non-immediate' data consists of:~~ ~~— data on the status of all satellites within the space segment;~~ ~~— coarse corrections to onboard time scales of each satellite relative to GLONASS time;~~ ~~— orbital parameters of all satellites within the space segment;~~ ~~— correction to GLONASS time relative to UTC (must remain within 1 microsecond).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (55)~~		~~State that integrity monitoring includes checking the quality of the characteristics of the navigation signal and the data within the navigation message.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
~~LO (56)~~		~~State that integrity monitoring is implemented in two ways:~~ ~~— Continuous automatic operability monitoring of~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~principal systems in each satellite. If a malfunction occurs, an 'unhealthy' flag appears within the 'immediate data' of the navigation message.~~ ~~— Special tracking stations within the ground-based control segment are used to monitor the space-segment performance. If a malfunction occurs, an 'unhealthy' flag appears within the 'immediate data' of the navigation message.~~								
(57)		State that agreements have been concluded between the appropriate agencies for the interoperability by any approved user of NAVSTAR and GLONASS systems.	X	X	X	X	X	X		
(58) New	X	State that the different GNSSs use different data with respect to reference systems, orbital data, and navigation services.	X	X	X	X	X	X		General statement about differences in GNSS instead of deleted details in this item 062 06 01 02 (46)
		~~**GALILEO**~~								Not in service LOs give too much technical details without practical use
~~LO (59)~~		~~State that the core of the Galileo constellation will consist of 30 satellites with 9 plus a spare replacement in each of the 3 planes in near circular orbit at an~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~altitude of 23 222 km inclined at 56° to the plane of the equator.~~								
~~LO (60)~~		~~State that the signals will be transmitted in 3 frequency bands: 1 164–1 215 MHz, 1 260–1 300 MHz and 1 559–1 591 MHz (1 559–1 591 MHz will be shared with GPS on a non-interference basis).~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~LO (61)~~		~~State that each orbit will take 14 hours.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~LO (62)~~		~~State that each satellite has three sections: timing, signal generation and transmit.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~LO (63)~~		~~State that in the 'timing section' two clocks have been developed, a Rubidium Frequency Standard clock and a more precise Passive Hydrogen Maser clock.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~LO (64)~~		~~State that the signal generation contains the navigation signals.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~LO (65)~~		~~State that the navigation signals consist of a ranging code identifier and the navigation message.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~LO (66)~~		~~State that the navigation message basically contains information concerning the satellite orbit (ephemeris) and the clock references.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~LO (67)~~		~~State that the navigation message is 'up-converted' on four navigation signal carriers and the outputs are combined in a multiplexer before transmission in the~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~transmit section.~~								
~~LO (68)~~		~~State that the navigation antenna has been designed to minimise interference between satellites by having equal power level propagation paths independent of elevation angle.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~LO (69)~~		~~State that the system is monitored in a similar way for both GPS NAVSTAR and GLONASS, but also by a new method based on spread-spectrum signals.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~LO (70)~~		~~State that tracking, telemetry and command operations are controlled by sophisticated data encryption and authentication procedures.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
~~LO (71)~~		~~GPS, EGNOS and GALILEO are compatible, will not interfere with each other, and the performance of the receiver will be enhanced by the interoperability of the systems.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		
		~~*GALILEO future developments*~~ ~~*Info: Further Learning Objectives will be written as details are released.*~~								
062 06 01 03		***Errors and factors affecting accuracy***								
(01)		List the most significant factors affecting accuracy: — ionospheric propagation delay;	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		— dilution of position; — satellite clock error; — satellite orbital variations; — multipath.								
(02)	X	State that ~~i~~Ionospheric p~~P~~ropagation d~~D~~elay (IPD) can almost be eliminated by using two frequencies.	X	X	X	X	X	X		
~~LO (03)~~		~~State that in SPS receivers, IPD is currently corrected by using the ionospheric model from the navigation message, but the error is only reduced by 50 %.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		No practical use
(04)	X	State that ionospheric delay is the most significant error.	X	X	X	X	X	X		
(05)		State that dilution of position arises from the geometry and number of satellites in view. It is called p~~P~~osition d~~D~~ilution of p~~P~~recision (PDOP).	X	X	X	X	X	X		
(06)	X	State that errors in the satellite orbits are due to: — solar wind; — gravitation of the Sun, Moon and planets.	X	X	X	X	X	X		
(07)		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).	X	X	X	X	X	X		
062 06 02 00		**Ground-, satellite- and airborne-based augmentation systems**								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
062 06 02 01		***Ground-b~~B~~based a~~A~~ugmentation s~~S~~ystems (GBASs)***								
(01)		Explain the principle of a GBAS: to measure on ground the signal errors transmitted by GNSS satellites and relay the measured errors to the user for correction.	X	X	X	X	X	X	X	
(02)	X	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).	X	X	X	X	X	X	X	
(03)		State that for a GBAS station the coverage is about 30 km.	X	X	X	X	X	X	X	
(04)	X	~~Explain~~ State that ICAO Standards provide the possibility to interconnect GBAS stations to form a network broadcasting large-scale differential corrections. Such a system is identified as g~~G~~round-based r~~R~~egional a~~A~~ugmentation s~~S~~ystem (GRAS).	X	X	X	X	X	X	X	Too high LO level
(05)		~~Explain~~ State that GBAS ground subsystems provide two services: precision approach service and GBAS positioning service. The precision approach service provides deviation guidance for final-approach s~~S~~egments, while the GBAS positioning service provides horizontal position information to support area navigation (RNAV) operations in terminal areas.	X	X	X	X	X	X	X	Too high LO level
~~LO (06)~~		~~Explain that one ground station can support all the~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		Irrelevant

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		~~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).~~								
(07)	X	~~State that the minimum GBAS plan coverage is 15 NM from the landing threshold point within 35° apart the final approach path and 10° apart between 15 and 20 NM.~~ State that the minimum coverage area is 10° on either side of the final approach path to a distance between 15 and 20 NM, and 35° on either side of the final approach path to a distance of 15 NM.	X	X	X	X	X	X		Clarified by new text
(08)	X	State that GBAS based on GPS is sometimes called l~~L~~ocal a~~A~~rea a~~A~~ugmentation s~~S~~ystem (LAAS).	X	X	X	X	X	X		
~~LO (09)~~		~~Describe the characteristics of a Local Area Augmentation System (LAAS) with respect to:~~ ~~— differential corrections applied to a satellite signal by a ground-based reference station;~~ ~~— regional service providers to compute the integrity of the satellite signals over their region;~~ ~~— extra accuracy for extended coverage around airports, railways, seaports and urban areas as required by the user.~~	X	X	X	X	X	X		Too detailed

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
062 06 02 02		***Satellite-bBased aAugmentation sSystems (SBASs)***								
(01)	X	Explain the principle of an SBAS: to measure on the ground the signal errors transmitted by GNSS satellites and transmit differential corrections and integrity messages for navigation satellites.	X	X	X	X	X	X	X	
(02)	X	State that the frequency band of the data link is identical to that of the GPS signals.	X	X	X	X	X	X	X	
(03)	X	Explain that the use of geostationary satellites enables messages to be broadcast over very wide areas.	X	X	X	X	X	X	X	
(04)	X	Explain that pseudo-range measurements to these geostationary satellites can also be made, as if they were GPS satellites.	X	X	X	X	X	X	X	
(05)	X	State that SBAS consists of three elements: — the ground infrastructure (monitoring and processing stations); — the SBAS satellites; — the SBAS airborne receivers.	X	X	X	X	X	X	X	
(06)	X	Explain that the SBAS station network measures the pseudo-range between the ranging source and an SBAS receiver at the known locations and provides separate corrections for ranging source ephemeris errors, clock errors and ionospheric errors. The user applies	X	X	X	X	X	X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		corrections for tropospheric delay.								
(07)		Explain that SBAS can provide approach ~~and landing operations~~ procedure with vertical guidance (APV)~~ and precision approach service~~.	X	X	X	X	X	X	X	
~~LO (08)~~		~~Explain the difference between 'coverage area' and 'service area'.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	Irrelevant
(09)	X	State that ~~Satellite-Based Augmentation Systems~~SBASs include: — 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) satellite-based augmentation system (MSAS) in Japan; — GPS and geostationary earth orbit augmented navigation (GAGAN) in India.	X	X	X	X	X	X	X	
(10)		Explain that SBASs ~~systems~~ regionally augment GPS and GLONASS by making them suitable for safety-critical ~~applications~~operations such as landing aircraft.	X	X	X	X	X	X		
062 06 02 03		***European g~~G~~eostationary n~~N~~avigation o~~O~~verlay s~~S~~ervice (EGNOS)***								
(01)	X	State that EGNOS consists of three geostationary	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		Inmarsat satellites which broadcast GPS lookalike signals.								
(02)	X	State that EGNOS is designed to improve accuracy to 1–2 m horizontally and 3–5 m vertically.	X	X	X	X	X	X	X	
(03)		Explain that integrity and safety are improved by alerting users within 6 seconds if a GPS malfunction occurs (up to 3 hours GPS alone).	X	X	X	X	X	X	X	
062 06 02 04		***Airborne-bBased aAugmentation sSystems (ABASs)***								
(01)		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.	X	X	X	X	X	X	X	
(02)		State that the type of ABAS using only GNSS information is named rReceiver aAutonomous iIntegrity mMonitoring (RAIM).	X	X	X	X	X	X	X	
(03)		State that a system using information from additional on-board sensors is named aAircraft aAutonomous iIntegrity mMonitoring (AAIM).	X	X	X	X	X	X	X	
(04)		Explain that the typical sensors used are barometric altimeter and inertial navigation system (INS).	X	X	X	X	X	X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
~~LO (05)~~		~~Explain that unlike GBAS and SBAS, ABAS does not improve positioning accuracy.~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	
062 07 00 00		**PERFORMANCE-BASED NAVIGATION (PBN)**								
062 07 01 00		**PBN concept (as described in ICAO D~~d~~oc 9613)**								
062 07 01 01		***PBN principles***								
(01)		List the factors used to define RNAV or required navigation performance (RNP) system performance requirements (accuracy, integrity, continuity and functionality).	X		X		X	X	X	
(02) New		State that these RNAV and RNP systems are necessary to optimise the utilisation of available airspace.	X		X			X		
(03) New		State that it is necessary for flight crews 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.	X		X			X		
(04) New		Define accuracy as the stated limits for the system error to be within for 95 % of the flight time.	X		X			X		
(05)		~~Explain the concept of continuity.~~ Define continuity as the capability of the system to perform its function without unscheduled interruptions	X		X			X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		during the intended operation.								
(06)		~~Explain the concept of integrity.~~ 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 warnings to the user (alerts).	X		X			X	X	
(07)		State that, unlike conventional navigation, ~~performance-based navigation~~ PBN is not sensor-specific.	X		X			X	X	
~~LO (08)~~		~~Explain the difference between raw data and computed data.~~	~~X~~		~~X~~			~~X~~	~~X~~	No practical use
062 07 01 02		***PBN components***								
(01)		List the components of PBN as navigational aid (NAVAID) infrastructure, navigation specification and navigation application.	X		X			X		
~~LO (02)~~		~~Identify the components from an example.~~	~~X~~		~~X~~			~~X~~		No practical use
062 07 01 03		***PBN scope***								
(01)		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.	X		X			X		
(02)		State that in the approach phases of flight, PBN accommodates both linear and angular laterally guided	X		X			X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		operations, and explain the difference between the two.								
062 07 02 00		**Navigation s~~S~~pecifications**								
062 07 02 01		***Area navigation (RNAV) and required navigation performance (RNP)***								
(01)		State the difference between RNAV and RNP in terms of the requirement for on-board performance monitoring and alerting.	X		X			X	X	
062 07 02 02		***Navigation functional requirements***								
(01)		List the basic functional requirements of RNAV and RNP specifications (continuous indication of lateral deviation, distance/bearing to active waypoint, g/s or time to active waypoint, navigation data storage and failure indication).	X		X			X		
062 07 02 03		***Designation of RNP and RNAV specifications***								
(01)		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 per cent of the flight time by the population of aircraft operating within the airspace, route or procedure.	X		X			X		
(02)		State that aircraft approved to the more stringent accuracy requirements may not necessarily meet some of the functional requirements of the navigation specification having a less stringent accuracy	X		X			X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		requirement.								
(03)		State that RNAV 10 and RNP 4 are used in the oceanic/remote phase of flight.	X		X			X		
(04)		State that RNAV 5 is used in the en-route and arrival phase of flight.	X		X			X		
(05)		State that RNAV 2 and RNP 2 are also used as navigation specifications.	X		X			X		
(06)		State that RNP 2 is used in the en-route~~,~~ and oceanic/remote phases of flight.	X		X			X		
(07)		State that RNAV 1 and RNP 1 are used in the arrival and departure phases of flight.	X		X			X		
(08)		State that required navigation performance approach (RNP APCH) is used in the approach phase of flight.	X		X			X		
(09)		State that required navigation performance authorisation required approach (RNP AR APCH) is used in the approach phase of flight.	X		X			X		
(10)		State that RNP 0.3 navigation specification is used in all phases of flight except for oceanic/remote and final approach, primarily for helicopters.	X		X			X		
(11) New		State that RNAV 1, RNP 1 and RNP 0.3 may also be used in en-route phases of low-level instrument flight rules	X		X			X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		(IFR) helicopter flights.								
062 07 03 00		**Use of PBN**								
062 07 03 01		***Airspace p~~P~~lanning***								
~~LO (01)~~		~~State that navigation performance is one factor used to determine minimum route spacing.~~	~~X~~		~~X~~			~~X~~	~~X~~	No practical use
062 07 03 02		***~~Approval~~ Intentionally left blank***								
~~LO (01)~~		~~State that the airworthiness approval process assures that each item of the area navigation equipment installed is of a type and design appropriate to its intended function and that the installation functions properly under foreseeable operating conditions.~~	~~X~~		~~X~~			~~X~~		No practical use
~~LO (02)~~		~~State that some PBN specifications require operational approval.~~	~~X~~		~~X~~			~~X~~	~~X~~	No practical use
062 07 03 03		***Specific RNAV and RNP system functions***								
(01)		Recognise the definition of a~~n~~ radius to fix (RF) leg.	X		X			X	X	
(02)		Recognise the definition of a fixed radius transition (FRT).	X		X			X	X	
(03) New		State the importance of respecting the flight director guidance and the speed constraints associated with an RF procedure.	X		X			X	X	
(04)		~~Recognise the definition of~~ Explain the difference	X		X			X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		between a fly-by-turn and a fly-over.								
~~LO (05)~~		~~Recognise the definition of a holding pattern.~~	~~X~~		~~X~~			~~X~~	~~X~~	Not specific to PBN
(06)		~~Recognise the definition of an 'ARINC 424 path terminator'.~~ State that the 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 ARINC navigation database format.	X		X			X		
(07)		~~Recognise the definition of the following path terminators: IF, TF, CF, DF, FA, CA.~~ State that the path terminators define a specific type of termination of the previous flight path.	X		X			X		
(08)		Recognise the definition of an offset flight path.	X		X			X	X	
062 07 03 04		~~***Data processes***~~ ***Intentionally left blank***								
~~LO (01)~~		~~State that the safety of the application is contingent upon the accuracy, resolution and integrity of the data.~~	~~X~~		~~X~~			~~X~~	~~X~~	
~~LO (02)~~		~~State that the accuracy of the data depends upon the processes applied during the data origination.~~	~~X~~		~~X~~			~~X~~		
062 07 04 00		**PBN operations**								
062 07 04 01		***PBN principles***								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(01)		~~Recognise the definition of path definition error.~~ Define the path definition error (PDE) and state that the PDE is assumed to be zero.	X		X			X	X	
(02)		~~Recognise the definition of flight technical error.~~ Define the flight technical error (FTE) and state that that the FTE is the error in following the prescribed path, either by the auto-flight system or by the pilot.	X		X			X	X	
(03)		~~Recognise the definition of navigation system error.~~ Define the navigation system error (NSE) and state that the accuracy of a navigation system may be referred to as NSE.	X		X			X	X	
(04)		~~Recognise the definition of total system error.~~ Define the total system error (TSE) and state that the geometric sum of the PDE, FTE and NSE equals the TSE.	X		X			X	X	
(05) New		State that navigation accuracy depends on the TSE.	X		X			X		
062 07 04 02		***On-board performance monitoring and alerting***								
(01)		State that on-board performance monitoring and alerting of flight technical error is managed by on-board systems or crew procedures.	X		X			X	X	
(02)		State that on-board performance monitoring and alerting of navigation system error is a requirement of on-board	X		X			X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		equipment for RNP.								
(03) New		State that, dependent on the navigation sensor, the estimated position error (EPE) is compared with the required navigation specification.	X		X			X		
(04) New		Explain how a navigation system assesses the EPE.	X		X			X		
(05) New		Give an example of how the loss of ability to operate in RNP airspace may be indicated by the navigation system.	X		X			X		
~~LO 6~~		~~State that on-board performance monitoring and alerting of path definition error are managed by gross reasonableness checks of navigation data.~~	~~X~~		~~X~~			~~X~~	~~X~~	PDE is defined to be zero — so no practical use
062 07 04 03		***Abnormal situations***								
(01)		State that abnormal and contingency procedures are to be used in case of ~~the~~ loss of the PBN capability.	X		X			X	X	
062 07 04 04		***Database management***								
(01)		State that, unless otherwise specified in operations documentation or acceptable means of compliance (AMC), the navigational database must be valid for the current aeronautical information regulation and control (AIRAC) cycle.	X		X			X	X	
062 07 05 00		**Requirements of specific RNAV and RNP specifications**								
062 07 05 01		***RNAV 10***								

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(01)		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 ~~IRS~~ (FMS) or a GNSS.	X		X			X		
(02)		State that aircraft incorporating dual ~~inertial navigation systems (~~INSs~~)~~ or inertial reference units (IRUs) have a standard time limitation.	X		X			X		
(03)		State that operators may extend their RNAV 10 navigation capability time by updating.	X		X			X		
062 07 05 02		***RNAV 5***								
(01)		State that manual data entry is acceptable for RNAV 5.	X		X			X		
062 07 05 03		***~~RNAV/RNP1/2~~ RNAV 1/RNAV 2/RNP 1/RNP 2***								
(01)		State that pilots must not fly an ~~RNAV/RNP1/2~~ 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.	X		X			X		
(02)		State that the route may subsequently be modified through the insertion (from the database) or deletion of specific waypoints in response to ATC clearances.	X		X			X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(03)		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.	X		X			X		
062 07 05 04		***RNP 4***								
(01)		State that at least two LRNSs, capable of navigating to RNP 4, and listed in the F~~f~~light M~~m~~anual, must be operational at the entry point of the RNP airspace and that consideration should be given to the use of direct controller–pilot communications (DCPC) (voice) or controller–pilot data link communications (CPDLC) communications, plus automatic dependent surveillance — contract (ADS-C) surveillance.	X		X			X		
062 07 05 05		***RNP APCH***								
(01)		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.	X		X			X	X	
(02)		State that an RNP APCH to LNAV minima is a non-precision ~~instrument approach procedure~~IAP designed for ~~2D~~two-dimensional approach operations.	X		X			X		
(03)		State that an RNP APCH to lateral navigation	X		X			X	X	

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		(LNAV)/vertical navigation (VNAV) minima has lateral guidance based on GNSS and vertical guidance based on either SBAS or BaroVNAV.								
(04)		State that an RNP APCH to LNAV/VNAV minima may only be conducted with vertical guidance certified for the purpose.	X		X			X	X	
(05)		Explain why an RNP APCH to LNAV/VNAV minima based on BaroVNAV may only be conducted when the aerodrome temperature is within a promulgated range if the barometric input is not automatically temperature-compensated.	X		X			X	X	
(06)		State that the correct altimeter setting is critical for the safe conduct of an RNP APCH using BaroVNAV.	X		X			X	X	
(07)		State that an RNP APCH to LNAV/VNAV minima is a ~~3D~~three-dimensional operation.	X		X			X		
(08)		State that an RNP APCH to localiser performance with vertical guidance (LPV) minima is a ~~3D~~three-dimensional operation.	X		X			X		
(09)		State that RNP APCH to LPV minima requires a final approach segment (FAS) data block.	X		X			X		
(10) New		State that RNP approaches to LPV minima require SBAS.	X		X			X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
(11) New		State that the FAS data block is a standard data format to describe the final approach path.	X		X			X		
062 07 05 06		***RNP AR APCH***								
(01)		State that RNP AR APCH requires authorisation.	X		X			X	X	
062 07 05 07		***Advanced required navigation performance (A-RNP)***								
(01)		State that ~~Advanced~~ A-RNP incorporates the navigation specifications RNAV 5, RNAV 2, RNAV 1, RNP 2, RNP 1 and RNP APCH.	X		X			X		
~~LO (02)~~		~~State that Advanced RNP may be associated with other functional elements.~~	~~X~~		~~X~~			~~X~~		Unclear
062 07 05 08		***PBN p~~P~~oint-in-s~~S~~pace (PinS) d~~D~~eparture***								
(01)		State that a PinS departure is a departure procedure designed for helicopters only.			X			X		
(02)		State that a PinS departure procedure includes either a 'proceed VFR' or a 'proceed visually' instruction from landing location to initial departure fix (IDF).			X			X		
(03)		Recognise the differences ~~between~~ in the instructions 'proceed VFR' and 'proceed visually' ~~instruction~~.			X			X		
062 07 05 09		***PBN p~~P~~oint-in-s~~S~~pace (PinS) a~~A~~pproach***								
(01)		State that a PinS approach is an instrument RNP APCH			X			X		

Syllabus reference	BK	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR	CBIR(A) & EIR	Comments
			ATPL	CPL	ATPL/ IR	ATPL	CPL			
		procedure designed for helicopters only, and that may be published with LNAV minima or LPV minima.								
(02)		State that a PinS approach procedure includes either a 'proceed VFR' or a 'proceed visually' instruction from the missed approach point (MAPt) to a landing location.			X			X		
(03)		Recognise the differences between 'proceed VFR' and 'proceed visually' ~~instruction~~.			X			X		