European Aviation Safety Agency

Notice of Proposed Amendment 2014-29 (D)(2)

Amendments to Commission Regulation (EU) No 1178/2011 (the Aircrew Regulation)

Learning Objectives (LOs)

RMT.0188 (FCL.002(a)) & RMT.0189 (FCL.002(b)) — 17.12.2014

EXECUTIVE SUMMARY

This Notice of Proposed Amendment (NPA) addresses a safety and regulatory coordination issue related to flight crew licensing.

The main objective of this NPA is to introduce the long syllabus and Learning Objectives (LOs) for professional licences and instrument ratings in the EASA regulatory system.

The NPA also aims to resolve any inconsistencies identified after the adoption of the FCL Implementing Rules. This is necessary to ensure that the EASA regulatory system reflects the state of the art, and specifically the best practices developed in the Member States, in the field of pilot training.

The following Safety Recommendations were taken into consideration for the development of this NPA: SR AUST-2012-006, SR BELG-2010-010, SR UNKG-2006-130, SR SWED-2010-008, SR SWED-2012-006, SR FRAN-2013-033, SR FRAN-2013-035 and SR FRAN-2013-017.

The specific objective of this NPA is to maintain a high level of safety for flight crews, to ensure harmonised implementation of the Aircrew Regulation, and to consider at all levels the importance of General Aviation issues.

— **NPA 2014-29 (A)** contains the Explanatory Note and the changes to the rule text of 'Annex I — Part-FCL', 'Annex II — Conditions for the conversion of existing national licences and ratings for aeroplanes and helicopters', and 'Annex III — Conditions for the acceptance of licences issued by or on behalf of third countries'.

  Due to the number of the proposed changes and the complexity of the text that was amended twice after its initial publication, the decision was taken to base the NPA on the amended text and to publish the changes to Annexes I, II and III in a consolidated version.

— **NPA 2014-29 (B)** contains the changes to the existing AMC and GM text.

— **NPAs 2014-29 (C)(1), (C)(2) and (C)(3)** contain the new AMC with the Flight Examiner Manual (FEM).

— **NPAs 2014-29 (D)(1) and (D)(2)** contain the new AMC with the Learning Objectives (LOs).

The proposed changes are expected to increase safety, reduce regulatory burden on Member States, improve harmonisation, ensure compliance with ICAO, and improve proportionality of the rules for General Aviation by applying the principles of the 'General Aviation Road Map'.

As indicated above, NPA 2014-29 (D)(2) contains the second part of the LOs. For the Explanatory Note, please refer to NPA 2014-29 (A).

Applicability	
Affected regulations and decisions:	Commission Regulation (EU) No 1178/2011, as amended; ED Decision 2011/016/R, as amended.
Affected stakeholders:	Pilots; training organisations; instructors; examiners; national competent authorities.
Driver/origin:	Safety; level playing field; proportionality; RMT FCL.001.
Reference:	EASA NPA 2008-17 'Implementing Rules for Pilot Licensing'.

Process map	
Concept Paper:	No
Terms of Reference:	21.7.2011
Rulemaking group:	Yes
RIA type:	None
Technical consultation during NPA drafting:	Yes
Duration of NPA consultation:	3 months
Review group:	TBD
Focussed consultation:	No
Publication date of the Opinion:	2015/Q4
Publication date of the Decision:	2015/Q4

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1. Procedural information

1.1. The rule development procedure

Please refer to NPA 2014-29 (A).

1.2. The structure of this NPA and related documents

Please refer to NPA 2014-29 (A).

1.3. How to comment on this NPA

Please submit your comments using the automated **Comment-Response Tool (CRT)** available at **http://hub.easa.europa.eu/crt/**[1].

The deadline for submission of comments is **17 March 2015.**

1.4. The next steps in the procedure

Please refer to NPA 2014-29 (A).

2. Explanatory Note

Please refer to NPA 2014-29 (A).

[1] In case of technical problems, please contact the CRT webmaster (crt@easa.europa.eu).

3. Proposed amendments

The text of the amendment is arranged to show deleted text, new or amended text as shown below:

(a) deleted text is marked with ~~strike through~~;

(b) new or amended text is highlighted in grey.

3.1. Draft Acceptable Means of Compliance and Guidance Material (Draft EASA Decision)

I. SUBJECT 050 — METEOROLOGY

The operation of an aircraft is affected by the weather conditions within the atmosphere. The pilot must 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 be able to:
- understand the physical processes in the atmosphere;
- interpret the actual and forecast weather conditions in the atmosphere;
- show understanding of the meteorological hazards and their effects on an aircraft.

(ii) Skills. After completion of the training, the pilot must 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;
- apply a solution to any problems presented by weather conditions.

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		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**						
LO	Describe the vertical division of the atmosphere, based on the temperature variations with height.	x	x	x	x	x	x
LO	List the different layers and their main qualitative characteristics.	x	x	x	x	x	x
050 01 01 02	**Troposphere**						
LO	Describe the troposphere.	x	x	x	x	x	x
LO	Describe the main characteristics of the tropopause.	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe the proportions of the most important gases in the air in the troposphere.	x	x	x	x	x	x
LO	Describe the variations of the flight level and temperature of the tropopause from the poles to the equator.	x	x	x	x	x	x
LO	Describe the breaks in the tropopause along the boundaries of the main air masses.	x	x	x	x	x	x
LO	Indicate the variations of the flight level of the tropopause with the seasons and the variations of atmospheric pressure.	x		x	x		
050 01 01 03	**Stratosphere**						
LO	Describe the stratosphere.	x		x	x		
LO	Describe the main differences of the composition of the air in the stratosphere compared to the troposphere.	x		x	x		
LO	Mention the vertical extent of the stratosphere up to the stratopause.	x		x	x		
LO	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**						
LO	Define 'air temperature'.	x	x	x	x	x	x
LO	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**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe the mean vertical distribution of temperature up to 20 km.	x	x	x	x	x	x
LO	Mention the general causes of the cooling of the air in the troposphere with increasing altitude.	x	x	x	x	x	x
LO	Calculate the temperature and temperature deviations at specified levels.	x	x	x	x	x	x
050 01 02 03	**Transfer of heat**						
LO	Explain how local cooling or warming processes result in transfer of heat.	x	x	x	x	x	x
LO	Describe radiation.	x	x	x	x	x	x
LO	Describe solar radiation reaching the Earth.	x	x	x	x	x	x
LO	Describe the filtering effect of the atmosphere on solar radiation.	x	x	x	x	x	x
LO	Describe terrestrial radiation.	x	x	x	x	x	x
LO	Explain how terrestrial radiation is absorbed by some components of the atmosphere.	x	x	x	x	x	x
LO	Explain the greenhouse effect due to water vapour and some other gases in the atmosphere.	x	x	x	x	x	x
LO	Explain the effect of absorption and radiation in connection with clouds.	x	x	x	x	x	x
LO	Explain the process of conduction.	x	x	x	x	x	x
LO	Explain the role of conduction in the cooling and warming of the atmosphere.	x	x	x	x	x	x
LO	Explain the process of convection.	x	x	x	x	x	x
LO	Name the situations in which convection occurs.	x	x	x	x	x	x
LO	Explain the process of advection.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Name the situations in which advection occurs.	x	x	x	x	x	x
LO	Describe the transfer of heat by turbulence.	x	x	x	x	x	x
LO	Describe the transfer of latent heat.	x	x	x	x	x	x
050 01 02 04	**Lapse rates**						
LO	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
050 01 02 05	**Development of inversions, types of inversions**						
LO	Describe the development and types of inversions.	x	x	x	x	x	x
LO	Explain the characteristics of inversions and of an isothermal layer.	x	x	x	x	x	x
LO	Explain the reasons for the formation of the following inversions: — ground inversion (nocturnal radiation/advection), subsidence inversion, frontal inversion, inversion above friction layer, valley inversion.	x	x	x	x	x	x
LO	Explain the reasons for the formation of the following inversions: — tropopause inversion.	x		x	x		
050 01 02 06	**Temperature near the Earth's surface, surface effects, diurnal and seasonal variation, effect of clouds, effect of wind**						
LO	Describe how the temperature near the Earth's surface is influenced by seasonal variations.	x	x	x	x	x	x
LO	Explain the cooling and warming of the air on the earth or sea surfaces.	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	_Aeroplane_		_Helicopter_			_IR_
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	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
LO	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
LO	Distinguish between the influence of low or high clouds and thick or thin clouds.	x	x	x	x	x	x
LO	Explain the influence of the wind on the cooling and warming of the air near the surfaces.	x	x	x	x	x	x
050 01 03 00	**Atmospheric pressure**						
050 01 03 01	**Barometric pressure, isobars**						
LO	Define ‘atmospheric pressure’.	x	x	x	x	x	x
LO	List the units of measurement of the atmospheric pressure used in aviation (hPa, inches). _(Refer to 050 10 01 01)_	x	x	x	x	x	x
LO	Describe the principle of the barometers (mercury barometer, aneroid barometer).	x	x	x	x	x	x
LO	Describe isobars on surface weather charts.	x	x	x	x	x	x
LO	Define ‘high’, ‘low’, ‘trough’, ‘ridge’, ‘wedge’, ‘col’.	x	x	x	x	x	x
050 01 03 02	**Pressure variation with height, contours (isohypses)**						
LO	Explain the pressure variation with height.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe qualitatively the variation of the barometric lapse rate. *Remark: The average value for the barometric lapse rate near mean sea level is 27 ft (8 m) per 1 hPa, at about 5 500 m/AMSL is 50 ft (15 m) per 1 hPa*.	x	x	x	x	x	x
LO	Describe and interpret contour lines (isohypses) on a constant pressure chart. *(Refer to 050 10 02 03)*	x	x	x	x	x	x
050 01 03 03	**Reduction of pressure to mean sea level, QFF**						
LO	Define 'QFF'.	x	x	x	x	x	x
LO	Explain the reduction of measured pressure to mean sea level, QFF.	x	x	x	x	x	x
LO	Mention the use of QFF for surface weather charts.	x	x	x	x	x	x
050 01 03 04	**Relationship between surface pressure centres and pressure centres aloft**						
LO	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
050 01 04 00	**Air density**						
050 01 04 01	**Relationship between pressure, temperature and density**						
LO	Describe the relationship between pressure, temperature and density.	x	x	x	x	x	x
LO	Describe the vertical variation of the air density in the atmosphere.	x	x	x	x	x	x
LO	Describe the effect of humidity changes on the density of air.	x	x	x	x	x	x
050 01 05 00	**ICAO Standard Atmosphere (ISA)**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
050 01 05 01	**ICAO Standard Atmosphere (ISA)**						
LO	Explain the use of standardised values for the atmosphere.	x	x	x	x	x	x
LO	List the main values of the ISA (mean sea-level pressure, mean sea-level temperature, the vertical temperature lapse rate up to 20 km, height and temperature of the tropopause).	x	x	x	x	x	x
LO	Calculate the standard temperature in Celsius for a given flight level.	x	x	x	x	x	x
LO	Determine a standard temperature deviation by the difference between the given outside-air temperature and the standard temperature.	x	x	x	x	x	x
050 01 06 00	**Altimetry**						
050 01 06 01	**Terminology and definitions**						
LO	Define the following terms and acronyms and explain how they are related to each other: height, altitude, pressure altitude, flight level, level, true altitude, true height, elevation, QNH, QFE, and standard altimeter setting.	x	x	x	x	x	x
LO	Describe the terms 'transition altitude', 'transition level', 'transition layer', 'terrain clearance', 'lowest usable flight level'.	x	x	x	x	x	x
050 01 06 02	**Altimeter settings**						
LO	Name the altimeter settings associated to height, altitude, pressure altitude and flight level.	x	x	x	x	x	x
LO	Describe the altimeter-setting procedures.	x	x	x	x	x	x
050 01 06 03	**Calculations**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Calculate the different readings on the altimeter when the pilot changes the altimeter setting.	x	x	x	x	x	x
LO	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
LO	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
LO	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
LO	Explain the influence of pressure areas on true altitude.	x	x	x	x	x	x
LO	Determine the true altitude/height for a given altitude/height and a given ISA temperature deviation.	x	x	x	x	x	x
LO	Calculate the terrain clearance and the lowest usable flight level for given atmospheric temperature and pressure conditions.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
	Remark: The following rules shall 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 27 ft (8 m) per 1 hPa;* *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 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 ground and the position of the aircraft.*						
050 01 06 04	**Effect of accelerated airflow due to topography**						
LO	Describe qualitatively how the effect of accelerated airflow due to topography (Bernoulli effect) affects altimetry.	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**						
LO	Define 'wind'.	x	x	x	x	x	x
LO	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
LO	Explain how wind is measured in meteorology.	x	x	x	x	x	x
050 02 02 00	**Primary cause of wind**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
050 02 02 01	**Primary cause of wind, pressure gradient, Coriolis force, gradient wind**						
LO	Define the term 'horizontal pressure gradient'.	x	x	x	x	x	x
LO	Explain how the pressure gradient force acts in relation to the pressure gradient.	x	x	x	x	x	x
LO	Explain how the Coriolis force acts in relation to the wind.	x	x	x	x	x	x
LO	Explain the development of the geostrophic wind.	x	x	x	x	x	x
LO	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
LO	Analyse the effect of changing latitude on the geostrophic-wind speed.	x		x	x		
LO	Explain the gradient wind effect and indicate how the gradient wind differs from the geostrophic wind in cyclonic and anticyclonic circulation.	x	x	x	x	x	x
050 02 02 02	**Variation of wind in the friction layer**						
LO	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
LO	State the surface and air-mass conditions that influence the wind in the friction layer (diurnal variation).	x	x	x	x	x	x
LO	Name the factors that influence the vertical extent of the friction layer.	x	x	x	x	x	x
LO	Explain the relationship between isobars and wind (direction and speed).	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
	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.*
over water	*ca 70 %*	*ca 10°*
over land	*ca 50 %*	*ca 30°*

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Syllabus reference	Syllabus details and associated Learning Objectives	ATPL	CPL	ATPL/ IR	ATPL	CPL	IR
050 02 02 03	**Effects of convergence and divergence**						
LO	Describe atmospheric convergence and divergence.	x	x	x	x	x	x
LO	Explain the effect of 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
050 02 03 00	**General global circulation**						
050 02 03 01	**General circulation around the globe**						
LO	Describe and explain the general global circulation. *(Refer to 050 08 01 01)*	x	x	x	x	x	x

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

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe turbulence and gustiness.	x	x	x	x	x	x
LO	List the common types of turbulence (convective, mechanical, orographic, frontal, clear-air turbulence).	x	x	x	x	x	x
050 02 06 02	**Formation and location of turbulence**						
LO	Explain the formation of convective turbulence, mechanical and orographic turbulence, frontal turbulence, clear-air turbulence. *(Refer to 050 02 06 03)*	x	x	x	x	x	x
LO	State where turbulence will normally be found (rough-ground surfaces, relief, inversion layers, CB, TS zones, unstable layers).	x	x	x	x	x	x
050 02 06 03	**Clear-Air Turbulence (CAT): Description, cause and location**						
LO	Describe the term CAT.	x	x	x	x	x	x
LO	Explain the formation of CAT. *(Refer to 050 02 06 02)*	x	x	x	x	x	x
LO	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**						
LO	Describe jet streams.	x	x	x	x	x	x
LO	State the defined minimum speed of a jet stream.	x	x	x	x	x	x
LO	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**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	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		
050 02 07 03	**Location of jet streams and associated CAT areas**						
LO	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	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		
LO	Describe and indicate the areas of worst wind shear and CAT.	x		x	x		
050 02 07 04	**Jet stream recognition**						
LO	State how jet streams may be recognised from their associated meteorological phenomena.	x		x	x		
050 03 00 00	**THERMODYNAMICS**						
050 03 01 00	**Humidity**						
050 03 01 01	**Water vapour in the atmosphere**						
LO	Describe humid air.	x	x	x	x	x	x
LO	Describe the significance for meteorology of water vapour in the atmosphere.	x	x	x	x	x	x
LO	Indicate the sources of atmospheric humidity.	x	x	x	x	x	x
050 03 01 02	**Mixing ratio**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Define 'mixing ratio' and 'saturation mixing ratio'.	x	x	x	x	x	x
LO	Name the unit used in meteorology to express the mixing ratio (g/kg).	x	x	x	x	x	x
LO	Explain the factors influencing the mixing ratio.	x	x	x	x	x	x
LO	Recognise the lines of equal mixing ratio on a simplified diagram (T, P).	x	x	x	x	x	x
LO	Define 'saturation of air by water vapour'.	x	x	x	x	x	x
LO	Illustrate with a diagram (T, mixing ratio) the influence of the temperature on the saturation mixing ratio, at constant pressure.	x	x	x	x	x	x
LO	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
050 03 01 03	**Temperature/dew point, relative humidity**						
LO	Define 'dew point'.	x	x	x	x	x	x
LO	Recognise the dew-point curve on a simplified diagram (T, P).	x	x	x	x	x	x
LO	Define 'relative humidity'.	x	x	x	x	x	x
LO	Explain the factors influencing the relative humidity at constant pressure.	x	x	x	x	x	x
LO	Explain the diurnal variation of the relative humidity.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe the relationship between relative humidity, the amount of water vapour and the temperature.	x	x	x	x	x	x
LO	Describe the relationship between temperature and dew point.	x	x	x	x	x	x
LO	Estimate the relative humidity of the air from the difference between dew point and temperature.	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**						
LO	Define 'condensation', 'evaporation', 'sublimation', 'freezing and melting' and 'latent heat'.	x	x	x	x	x	x
LO	List the conditions for condensation/ evaporation.	x	x	x	x	x	x
LO	Explain the condensation process.	x	x	x	x	x	x
LO	Explain the nature of and the need for condensation nuclei.	x	x	x	x	x	x
LO	Explain the effects of condensation on the weather.	x	x	x	x	x	x
LO	List the conditions for freezing/ melting.	x	x	x	x	x	x
LO	Explain the process of freezing.	x	x	x	x	x	x
LO	Explain the nature of and the need for freezing nuclei.	x	x	x	x	x	x
LO	Define 'supercooled water'. *(Refer to 050 09 01 01)*	x	x	x	x	x	x
LO	List the conditions for sublimation.	x	x	x	x	x	x
LO	Explain the sublimation process.	x	x	x	x	x	x
LO	Explain the nature of and the need for sublimation nuclei.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe the absorption or release of latent heat in each change of state of aggregation.	x	x	x	x	x	x
LO	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
LO	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	Describe the adiabatic processes.	x	x	x	x	x	x
LO	Describe the adiabatic process in an unsaturated rising or descending air particle.	x	x	x	x	x	x
LO	Explain the variation of temperature with changing altitude.	x	x	x	x	x	x
LO	Explain the changes which take place in mixing ratio with changing altitude.	x	x	x	x	x	x
LO	Explain the changes which take place in relative humidity with changing altitude.	x	x	x	x	x	x
LO	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
LO	Describe the adiabatic process in a saturated rising or descending air particle.	x	x	x	x	x	x
LO	Explain the variation of temperature with changing altitude.	x	x	x	x	x	x
LO	Explain the difference in temperature lapse rate between saturated and unsaturated air.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Explain the influence of different air temperatures on the temperature lapse rate in saturated air.	x	x	x	x	x	x
LO	Use the saturated adiabatic lines on a simplified diagram (T, P) for a climbing or descending air particle.	x	x	x	x	x	x
LO	Find the condensation level, or base of the clouds, on a simplified diagram (T, P).	x	x	x	x	x	x
LO	Explain the static stability of the atmosphere with reference to the adiabatic lapse rates.	x	x	x	x	x	x
LO	Define qualitatively and quantitatively the terms 'stability', 'conditional instability', 'instability' and 'indifferent (neutral)'.	x	x	x	x	x	x
LO	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
LO	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
LO	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
LO	Illustrate with a schematic sketch the formation of the subsidence inversion.	x	x	x	x	x	x
LO	Illustrate with a schematic sketch the formation of Foehn.	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Explain the effect on the stability of the air caused by advection of air (warm or cold). *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).*	x	x	x	x	x	x
050 04 00 00	**CLOUDS AND FOG**						
050 04 01 00	**Cloud formation and description**						
050 04 01 01	**Cloud formation**						
LO	Explain cloud formation by adiabatic cooling, conduction, advection and radiation.	x	x	x	x	x	x
LO	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
LO	Determine cloud base and top in a simplified diagram (temperature, pressure, humidity).	x	x	x	x	x	x
LO	Explain the influence of relative humidity on the height of the cloud base.	x	x	x	x	x	x
LO	Illustrate in a thermodynamic diagram the meaning of convective temperature (temperature at which formation of cumulus starts).	x	x	x	x	x	x
LO	List cloud types typical for stable and unstable air conditions.	x	x	x	x	x	x
LO	Summarise the conditions for the dissipation of clouds.	x	x	x	x	x	x
050 04 01 02	**Cloud types and cloud classification**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe cloud types and cloud classification.	x	x	x	x	x	x
LO	Identify by shape cirriform, cumuliform and stratiform clouds.	x	x	x	x	x	x
LO	Identify by shape and typical level the 10 cloud types (genera).	x	x	x	x	x	x
LO	Describe and identify by shape the following species and supplementary feature: castellanus, lenticularis, fractus, humilis, mediocris, congestus, calvus, capillatus and virga.	x	x	x	x	x	x
LO	Distinguish between low, medium and high-level clouds according to the WMO 'cloud etage' (including heights): — for mid latitudes.	x	x	x	x	x	x
LO	Distinguish between low, medium and high-level clouds according to the WMO 'cloud etage' (including heights): — for all latitudes.	x		x	x		
LO	Distinguish between ice clouds, mixed clouds and pure-water clouds.	x	x	x	x	x	x
050 04 01 03	**Influence of inversions on cloud development**						
LO	Explain the influence of inversions on vertical movements in the atmosphere.	x	x	x	x	x	x
LO	Explain the influence of an inversion on the formation of stratus clouds.	x	x	x	x	x	x
LO	Explain the influence of ground inversion on the formation of fog.	x	x	x	x	x	x
LO	Determine on a simplified diagram the top of a cumulus cloud caused by an inversion.	x	x	x	x	x	x
LO	Describe the role of the tropopause inversion with regard to the formation of clouds.	x		x	x		
050 04 01 04	**Flying conditions in each cloud type**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Assess the 10 cloud types for icing and turbulence.	x	x	x	x	x	x
050 04 02 00	**Fog, mist, haze**						
050 04 02 01	**General aspects**						
LO	Define ‘fog’, ‘mist’ and ‘haze’ with reference to the WMO standards of visibility range.	x	x	x	x	x	x
LO	Explain the formation of fog, mist and haze in general.	x	x	x	x	x	x
LO	Name the factors contributing in general to the formation of fog and mist.	x	x	x	x	x	x
LO	Name the factors contributing to the formation of haze.	x	x	x	x	x	x
LO	Describe freezing fog and ice fog.	x	x	x	x	x	x
050 04 02 02	**Radiation fog**						
LO	Explain the formation of radiation fog.	x	x	x	x	x	x
LO	Explain the conditions for the development of radiation fog.	x	x	x	x	x	x
LO	Describe the significant characteristics of radiation fog, and its vertical extent.	x	x	x	x	x	x
LO	Summarise the conditions for the dissipation of radiation fog.	x	x	x	x	x	x
050 04 02 03	**Advection fog**						
LO	Explain the formation of advection fog.	x	x	x	x	x	x
LO	Explain the conditions for the development of advection fog.	x	x	x	x	x	x
LO	Describe the different possibilities of advection-fog formation (over land, sea and coastal regions).	x	x	x	x	x	x
LO	Describe the significant characteristics of advection fog.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Summarise the conditions for the dissipation of advection fog.	x	x	x	x	x	x
050 04 02 04	**Steam fog**						
LO	Explain the formation of steam fog.	x	x	x	x	x	x
LO	Explain the conditions for the development of steam fog.	x	x	x	x	x	x
LO	Describe the significant characteristics of steam fog.	x	x	x	x	x	x
LO	Summarise the conditions for the dissipation of steam fog.	x	x	x	x	x	x
050 04 02 05	**Frontal fog**						
LO	Explain the formation of frontal fog.	x	x	x	x	x	x
LO	Explain the conditions for the development of frontal fog.	x	x	x	x	x	x
LO	Describe the significant characteristics of frontal fog.	x	x	x	x	x	x
LO	Summarise the conditions for the dissipation of frontal fog.	x	x	x	x	x	x
050 04 02 06	**Orographic fog (hill fog)**						
LO	Summarise the features of orographic fog.	x	x	x	x	x	x
LO	Explain the conditions for the development of orographic fog.	x	x	x	x	x	x
LO	Describe the significant characteristics of orographic fog.	x	x	x	x	x	x
LO	Summarise the conditions for the dissipation of orographic fog.	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**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Distinguish between the two following processes by which precipitation is formed.	x	x	x	x	x	x
LO	Summarise the outlines of the ice-crystal process (Wegener-Bergeron-Findeisen).	x	x	x	x	x	x
LO	Summarise the outlines of the coalescence process.	x	x	x	x	x	x
LO	Describe the atmospheric conditions that favour either process.	x	x	x	x	x	x
LO	Explain the development of snow, rain, drizzle and hail.	x	x	x	x	x	x
050 05 02 00	**Types of precipitation**						
050 05 02 01	**Types of precipitation, relationship with cloud types**						
LO	List and describe the types of precipitation given in the TAF and METAR codes (drizzle, rain, snow, snow grains, ice pellets, hail, small hail, snow pellets, ice crystals, freezing drizzle, freezing rain).	x	x	x	x	x	x
LO	State the ICAO/WMO approximate diameters for cloud, drizzle and rain drops.	x	x	x	x	x	x
LO	State the approximate weights and diameters for hailstones.	x	x	x	x	x	x
LO	Explain the mechanism for the formation of freezing precipitation.	x	x	x	x	x	x
LO	Describe the weather conditions that give rise to freezing precipitation.	x	x	x	x	x	x
LO	Distinguish between the types of precipitation generated in convective and stratiform cloud.	x	x	x	x	x	x
LO	Assign typical precipitation types and intensities to different clouds.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
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**						
LO	Define the term ‘air mass’.	x	x	x	x	x	x
LO	Describe the properties of the source regions.	x	x	x	x	x	x
LO	Summarise the classification of air masses by source regions.	x	x	x	x	x	x
LO	State the classifications of air masses by temperature and humidity at source.	x	x	x	x	x	x
LO	State the characteristic weather in each of the air masses.	x	x	x	x	x	x
LO	Name the three main air masses that affect Europe.	x	x	x	x	x	x
LO	Classify air masses on a surface weather chart.	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 • *cold (c),* • *warm (w).*						
050 06 01 02	**Modifications of air masses**						
LO	List the environmental factors that affect the final properties of an air mass.	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Explain how maritime and continental tracks modify air masses.	x	x	x	x	x	x
LO	Explain the effect of passage over cold or warm surfaces.	x	x	x	x	x	x
LO	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
LO	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
050 06 02 00	**Fronts**						
050 06 02 01	**General aspects**						
LO	Describe the boundaries between air masses (fronts).	x	x	x	x	x	x
LO	Define ‘front and frontal surface (frontal zone)’.	x	x	x	x	x	x
LO	Name the global frontal systems (polar front, arctic front).	x	x	x	x	x	x
LO	State the approximate seasonal latitudes and geographic positions of the polar front and the arctic front.	x	x	x	x	x	x
050 06 02 02	**Warm front, associated clouds and weather**						
LO	Define a ‘warm front’.	x	x	x	x	x	x
LO	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
LO	Explain the seasonal differences in the weather at warm fronts.	x	x	x	x	x	x
LO	Describe the structure, slope and dimensions of a warm front.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Sketch a cross section of a warm front showing weather, cloud and aviation hazards.	x	x	x	x	x	x
050 06 02 03	**Cold front, associated clouds and weather**						
LO	Define a 'cold front'.	x	x	x	x	x	x
LO	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
LO	Explain the seasonal differences in the weather at cold fronts.	x	x	x	x	x	x
LO	Describe the structure, slope and dimensions of a cold front.	x	x	x	x	x	x
LO	Sketch a cross section of a cold front showing weather, cloud and aviation hazards.	x	x	x	x	x	x
050 06 02 04	**Warm sector, associated clouds and weather**						
LO	Define 'fronts and air masses associated with the warm sector'.	x	x	x	x	x	x
LO	Describe the cloud, weather, ground visibility and aviation hazards in a warm sector.	x	x	x	x	x	x
LO	Explain the seasonal differences in the weather in the warm sector.	x	x	x	x	x	x
LO	Sketch a cross section of a warm sector showing weather, cloud and aviation hazards.	x	x	x	x	x	x
050 06 02 05	**Weather behind the cold front**						
LO	Describe the cloud, weather, ground visibility and aviation hazards behind the cold front.	x	x	x	x	x	x
LO	Explain the seasonal differences in the weather behind the cold front.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
050 06 02 06	**Occlusions, associated clouds and weather**						
LO	Define the term 'occlusion'.	x	x	x	x	x	x
LO	Define a 'cold occlusion'.	x	x	x	x	x	x
LO	Define a 'warm occlusion'.	x	x	x	x	x	x
LO	Describe the cloud, weather, ground visibility and aviation hazards in a cold occlusion.	x	x	x	x	x	x
LO	Describe the cloud, weather, ground visibility and aviation hazards in a warm occlusion.	x	x	x	x	x	x
LO	Explain the seasonal differences in the weather at occlusions.	x	x	x	x	x	x
LO	Sketch a cross section of cold and warm occlusions showing weather, cloud and aviation hazards.	x	x	x	x	x	x
LO	On a sketch illustrate the development of an occlusion and the movement of the occlusion point.	x	x	x	x	x	x
050 06 02 07	**Stationary front, associated clouds and weather**						
LO	Define a 'stationary or quasi-stationary front'.	x	x	x	x	x	x
LO	Describe the cloud, weather, ground visibility and aviation hazards in a stationary or quasi-stationary front.	x	x	x	x	x	x
050 06 02 08	**Movement of fronts and pressure systems, life cycle**						
LO	Describe the movements of fronts and pressure systems and the life cycle of a mid-latitude depression.	x	x	x	x	x	x
LO	State the rules for predicting the direction and the speed of movement of fronts.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Explain the difference between the speed of movement of cold and warm fronts.	x	x	x	x	x	x
LO	State the rules for predicting the direction and the speed of movement of frontal depressions.	x	x	x	x	x	x
LO	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
050 06 02 09	**Changes of meteorological elements at a frontal wave**						
LO	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
050 07 00 00	**PRESSURE SYSTEMS**						
050 07 01 00	**The principal pressure areas**						
050 07 01 01	**Location of the principal pressure areas**						
LO	Identify or indicate on a map the principal global high-pressure and low-pressure areas in January and July.	x		x	x		
LO	Explain how these pressure areas are formed.	x		x	x		
LO	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**						
LO	List the different types of anticyclones.	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe the effect of high-level convergence in producing areas of high pressure at ground level.	x	x	x	x	x	x
LO	Describe air-mass subsidence, its effect on the environmental lapse rate, and the associated weather.	x	x	x	x	x	x
LO	Describe the formation of warm and cold anticyclones.	x	x	x	x	x	x
LO	Describe the formation of ridges and wedges. *(Refer to 050 08 03 02)*	x	x	x	x	x	x
LO	Describe the properties of and the weather associated with warm and cold anticyclones.	x	x	x	x	x	x
LO	Describe the properties of and the weather associated with ridges and wedges.	x	x	x	x	x	x
LO	Describe the blocking anticyclone and its effects.	x	x	x	x	x	x
050 07 03 00	**Non-frontal depressions**						
050 07 03 01	**Thermal, orographic, polar and secondary depressions; troughs**						
LO	Describe the effect of high-level divergence in producing areas of low pressure at ground level.	x	x	x	x	x	x
LO	Describe the formation and properties of thermal, orographic (lee lows), polar and secondary depressions.	x	x	x	x	x	x
LO	Describe the formation, the properties and the associated weather of troughs.	x	x	x	x	x	x
050 07 04 00	**Tropical revolving storms**						
050 07 04 01	**Characteristics of tropical revolving storms**						
LO	State the conditions necessary for the formation of tropical revolving storms.	x		x	x		

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Explain how a tropical revolving storm moves during its life cycle.	x		x	x		
LO	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		
LO	Describe the meteorological conditions in and near a tropical revolving storm.	x		x	x		
LO	State the approximate dimensions of a tropical revolving storm.	x		x	x		
050 07 04 02	**Origin and local names, location and period of occurrence**						
LO	List the areas of origin and occurrence of tropical revolving storms, and their specified names (hurricane, typhoon, tropical cyclone).	x		x	x		
LO	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**						
LO	Describe the general tropospheric and low stratospheric circulation. *(Refer to 050 02 03 01)*	x		x	x		
050 08 01 02	**Climatic classification**						
LO	Name the world climate groups according to Koeppen's classification.	x		x	x		

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe the characteristics of the tropical rain climate, the dry climate, the mid-latitude climate (warm temperate rain climate), the subarctic climate (cold snow-forest climate) and the snow climate (polar climate).	x		x	x		
LO	Explain how the seasonal movement of the sun generates the transitional climate zones.	x		x	x		
LO	Describe the typical weather in the tropical transitional climate (savannah climate) and in the temperate transitional climate (Mediterranean climate).	x		x	x		
LO	State the typical locations of each major climatic zone.	x		x	x		
050 08 02 00	**Tropical climatology**						
050 08 02 01	**Cause and development of tropical showers and thunderstorms: humidity, temperature, tropopause**						
LO	State the conditions necessary for the formation of tropical rain showers and thunderstorms (mesoscale convective complex, cloud clusters).	x		x	x		
LO	Describe the characteristics of tropical squall lines.	x		x	x		
LO	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		
LO	State the typical figures for tropical surface air temperatures and humidities, and heights of the zero-degree isotherm.	x		x	x		
050 08 02 02	**Seasonal variations of weather and wind, typical synoptic situations**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe the seasonal variations of weather and winds, and describe the typical synoptic situations.	x		x	x		
LO	Indicate on a map the trade winds (tropical easterlies) and describe the associated weather.	x		x	x		
LO	Indicate on a map the doldrums and describe the associated weather.	x		x	x		
LO	Indicate on a sketch the latitudes of subtropical high (horse latitudes) and describe the associated weather.	x		x	x		
LO	Indicate on a map the major monsoon winds. *(Refer to 050 08 02 04 for a description of the weather)*	x		x	x		
050 08 02 03	**Intertropical Convergence Zone (ITCZ), weather in the ITCZ, general seasonal movement**						
LO	Identify or indicate on a map the positions of the ITCZ in January and July.	x		x	x		
LO	Explain the seasonal movement of the ITCZ.	x		x	x		
LO	Describe the weather and winds at the ITCZ.	x		x	x		
LO	Explain the variations in weather that are found at the ITCZ.	x		x	x		
LO	Explain the flight hazards associated with the ITCZ.	x		x	x		
050 08 02 04	**Monsoon, sandstorms, cold-air outbreaks**						
LO	Define in general the term 'monsoon'.	x		x	x		
LO	Describe the major monsoon conditions. *(Refer to 050 08 02 02)*	x		x	x		

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Explain how trade winds change character after a long track and become monsoon winds.	x		x	x		
LO	Explain the formation of the SW/NE monsoon over West Africa and describe the weather, stressing the seasonal differences.	x		x	x		
LO	Explain the formation of the SW/NE monsoon over India and describe the weather, stressing the seasonal differences.	x		x	x		
LO	Explain the formation of the monsoon over the Far East and northern Australia and describe the weather, stressing the seasonal differences.	x		x	x		
LO	Describe the formation and properties of sandstorms.	x		x	x		
LO	Indicate when and where outbreaks of cold polar air can enter subtropical weather systems.	x		x	x		
LO	Name well-known examples of polar-air outbreaks (Blizzard, Pampero).	x		x	x		
050 08 02 05	**Easterly waves**						
LO	Describe and explain the formation of easterly waves, the associated weather and the duration of the weather activity.	x		x	x		
LO	Describe and explain the global distribution of easterly waves.	x		x	x		
LO	Explain the effect of easterly waves on tropical weather systems.	x		x	x		
050 08 03 00	**Typical weather situations in the mid-latitudes**						
050 08 03 01	**Westerly situation (westerlies)**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Identify on a weather chart the typical westerly situation with travelling polar front waves.	x	x	x	x	x	x
LO	Describe the typical weather in the region of the travelling polar front waves including the seasonal variations.	x	x	x	x	x	x
LO	State the differences between the northern and the southern hemisphere (roaring forties).	x		x	x		
050 08 03 02	**High-pressure area**						
LO	Describe the high-pressure zones with the associated weather.	x	x	x	x	x	x
LO	Identify on a weather chart the high-pressure regions.	x	x	x	x	x	x
LO	Describe the weather associated with wedges in the polar air. *(Refer to 050 07 02 01)*	x	x	x	x	x	x
050 08 03 03	**Flat-pressure pattern**						
LO	Identify on a surface weather chart the typical flat-pressure pattern.	x	x	x	x	x	x
LO	Describe the weather associated with a flat-pressure pattern.	x	x	x	x	x	x
050 08 03 04	**Cold-air pool (cold-air drop)**						
LO	Define 'cold-air pool'.	x	x	x	x	x	x
LO	Describe the formation of a cold-air pool.	x	x	x	x	x	x
LO	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
LO	Identify cold-air pools on weather charts.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Explain the problems and dangers of cold-air pools for aviation.	x	x	x	x	x	x
050 08 04 00	**Local winds and associated weather**						
050 08 04 01	**Foehn, Mistral, Bora, Scirocco, Ghibli and Khamsin**						
LO	Describe the classical mechanism for the development of Foehn winds (including Chinook).	x	x	x	x	x	x
LO	Describe the weather associated with Foehn winds.	x	x	x	x	x	x
LO	Describe the formation of, the characteristics of, and the weather associated with the Mistral, the Bora, the Scirocco, the Ghibli and the Khamsin.	x	x	x	x	x	x
050 08 04 02	**Harmattan**						
LO	Describe the Harmattan wind and the associated visibility problems.	x		x	x		
050 09 00 00	**FLIGHT HAZARDS**						
050 09 01 00	**Icing**						
050 09 01 01	**Conditions for ice accretion**						
LO	Summarise the general conditions under which ice accretion occurs on aircraft (temperatures of outside air; temperature of the airframe; presence of supercooled water in clouds, fog, rain and drizzle; possibility of sublimation).	x	x	x	x	x	x
LO	Indicate the general weather conditions under which ice accretion in Venturi carburettor occurs.	x	x	x	x	x	x
LO	Explain the general weather conditions under which ice accretion on airframe occurs.	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Explain the formation of supercooled water in clouds, rain and drizzle. *(Refer to 050 03 02 01)*	x	x	x	x	x	x
LO	Explain qualitatively the relationship between the air temperature and the amount of supercooled water.	x	x	x	x	x	x
LO	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
LO	Indicate in which circumstances ice can form on an aircraft on the ground: air temperature, humidity, precipitation.	x	x	x	x	x	x
LO	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
LO	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
LO	Explain the effects of topography on icing.	x	x	x	x	x	x
LO	Explain the higher concentration of water drops in stratiform orographic clouds.	x	x	x	x	x	x
050 09 01 02	**Types of ice accretion**						
LO	Define ‘clear ice’.	x	x	x	x	x	x
LO	Describe the conditions for the formation of clear ice.	x	x	x	x	x	x
LO	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

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe the aspect of clear ice: appearance, weight, solidity.	x	x	x	x	x	x
LO	Define 'rime ice'.	x	x	x	x	x	x
LO	Describe the conditions for the formation of rime ice.	x	x	x	x	x	x
LO	Describe the aspects of rime ice: appearance, weight, solidity.	x	x	x	x	x	x
LO	Define 'mixed ice'.	x	x	x	x	x	x
LO	Describe the conditions for the formation of mixed ice.	x	x	x	x	x	x
LO	Describe the aspects of mixed ice: appearance, weight, solidity.	x	x	x	x	x	x
LO	Describe the possible process of ice formation in snow conditions.	x	x	x	x	x	x
LO	Define 'hoar frost'.	x	x	x	x	x	x
LO	Describe the conditions for the formation of hoar frost.	x	x	x	x	x	x
LO	Describe the aspects of hoar frost: appearance, solidity.	x	x	x	x	x	x
050 09 01 03	**Hazards of ice accretion, avoidance**						
LO	State the ICAO qualifying terms for the intensity of icing. *(See ICAO ATM Doc 4444)*	x	x	x	x	x	x
LO	Describe, in general, the hazards of icing.	x	x	x	x	x	x
LO	Assess the dangers of the different types of ice accretion.	x	x	x	x	x	x
LO	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

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Indicate the possibilities of avoidance: — in the flight planning: weather briefing, choice of track and altitude; — during flight: recognition of the dangerous zones, choice of appropriate track and altitude.	x	x	x	x	x	x
050 09 02 00	**Turbulence**						
050 09 02 01	**Effects on flight, avoidance**						
LO	State the ICAO qualifying terms for the intensity of turbulence. *(See ICAO ATM Doc 4444)*	x	x	x	x	x	x
LO	Describe the effects of turbulence on an aircraft in flight.	x	x	x	x	x	x
LO	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
050 09 02 02	**Clear-Air Turbulence (CAT): effects on flight, avoidance**						
LO	Describe the effects on flight caused by CAT. *(Refer to 050 02 06 03)*	x		x	x		
LO	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**						
LO	Define ‘wind shear’ (vertical and horizontal).	x	x	x	x	x	x
LO	Define ‘low-level wind shear’.	x	x	x	x	x	x
050 09 03 02	**Weather conditions for wind shear**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	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
050 09 03 03	**Effects on flight, avoidance**						
LO	Describe the effects on flight caused by wind shear.	x	x	x	x	x	x
LO	Indicate the possibilities of avoidance: — in the flight planning; — during flight.	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**						
LO	Name the cloud types which indicate the development of thunderstorms.	x	x	x	x	x	x
LO	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
050 09 04 02	**Structure of thunderstorms, life history**						
LO	Describe and sketch the stages of the life history of a thunderstorm: initial, mature and dissipating stage.	x	x	x	x	x	x
LO	Assess the average duration of thunderstorms and their different stages.	x	x	x	x	x	x
LO	Describe supercell storm: initial, supercell, tornado and dissipating stage.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Summarise the flight hazards of a fully developed thunderstorm.	x	x	x	x	x	x
LO	Indicate on a sketch the most dangerous zones in and around a thunderstorm.	x	x	x	x	x	x
050 09 04 03	**Electrical discharges**						
LO	Describe the basic outline of the electric field in the atmosphere.	x	x	x	x	x	x
LO	Describe the electrical potential differences in and around a thunderstorm.	x	x	x	x	x	x
LO	Describe and asses the 'St. Elmo's fire' weather phenomenon.	x	x	x	x	x	x
LO	Describe the development of lightning discharges.	x	x	x	x	x	x
LO	Describe the effect of lightning strike on aircraft and flight execution.	x	x	x	x	x	x
050 09 04 04	**Development and effects of downbursts**						
LO	Define the term 'downburst'.	x	x	x	x	x	x
LO	Distinguish between macroburst and microburst.	x	x	x	x	x	x
LO	State the weather situations leading to the formation of downbursts.	x	x	x	x	x	x
LO	Describe the process of development of a downburst.	x	x	x	x	x	x
LO	Give the typical duration of a downburst.	x	x	x	x	x	x
LO	Describe the effects of downbursts.	x	x	x	x	x	x
050 09 04 05	**Thunderstorm avoidance**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	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
LO	Describe practical examples of flight techniques used to avoid the hazards of thunderstorms.	x	x	x	x	x	x
050 09 05 00	**Tornadoes**						
050 09 05 01	**Properties and occurrence**						
LO	Define the 'tornado'.	x	x	x	x	x	x
LO	Describe the formation of a tornado.	x		x	x		
LO	Describe the typical features of a tornado such as appearance, season, time of day, stage of development, speed of movement and wind speed (including Fujita scale).	x		x	x		
LO	Compare the occurrence of tornadoes in Europe with the occurrence in other locations, especially in the United States of America.	x		x	x		
LO	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	Explain the influence of inversions on the aircraft performance.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Compare the flight hazards during take-off and approach associated to a strong inversion alone and to a strong inversion combined with marked wind shear.	x	x	x	x	x	x
050 09 07 00	**Stratospheric conditions**						
050 09 07 01	**Influence on aircraft performance**						
LO	Summarise the advantages of stratospheric flights.	x		x	x		
LO	List the influences of the phenomena associated with the lower stratosphere (wind, temperature, air density, turbulence).	x		x	x		
050 09 08 00	**Hazards in mountainous areas**						
050 09 08 01	**Influence of terrain on clouds and precipitation, frontal passage**						
LO	Describe the influence of a mountainous terrain on cloud and precipitation.	x	x	x	x	x	x
LO	Describe the effects of the Foehn.	x	x	x	x	x	x
LO	Describe the influence of a mountainous area on a frontal passage.	x	x	x	x	x	x
050 09 08 02	**Vertical movements, mountain waves, wind shear, turbulence, ice accretion**						
LO	Describe the vertical movements, wind shear and turbulence typical of mountain areas.	x	x	x	x	x	x
LO	Indicate in a sketch of a chain of mountains the turbulent zones (mountain waves, rotors).	x	x	x	x	x	x
LO	Explain the influence of relief on ice accretion.	x	x	x	x	x	x
050 09 08 03	**Development and effect of valley inversions**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe the formation of valley inversion due to katabatic winds.	x	x	x	x	x	x
LO	Describe the valley inversion formed by warm winds aloft.	x	x	x	x	x	x
LO	Describe the effects of a valley inversion for an aircraft in flight.	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**						
LO	Describe the reduction of visibility caused by precipitation: drizzle, rain, snow.	x	x	x	x	x	x
LO	Describe the reduction of visibility caused by obscurations: — fog, mist, haze, smoke, volcanic ash.	x	x	x	x	x	x
LO	Describe the reduction of visibility caused by obscurations: — sand (SA), dust (DU).	x		x	x		
LO	Describe the differences between ground visibility, 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
050 09 09 02	**Reduction of visibility caused by other phenomena**						
LO	Describe the reduction of visibility caused by: — low drifting and blowing snow.	x	x	x	x	x	x
LO	Describe the reduction of visibility caused by: — low drifting and blowing dust and sand.	x		x	x		
LO	Describe the reduction of visibility caused by: — dust storm (DS) and sandstorm (SS).	x		x	x		
LO	Describe the reduction of visibility caused by: — icing (windshield).	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe the reduction of visibility caused by: — the position of the sun relative to the visual direction.	x	x	x	x	x	x
LO	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
050 10 00 00	**METEOROLOGICAL INFORMATION**						
050 10 01 00	**Observation**						
050 10 01 01	**Surface observations**						
LO	Define 'surface wind'.	x	x	x	x	x	x
LO	Describe the meteorological measurement of surface wind.	x	x	x	x	x	x
LO	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
LO	Define 'gusts', as given in METARs.	x	x	x	x	x	x
LO	Distinguish wind given in METARs and wind given by the control tower for take-off and landing.	x	x	x	x	x	x
LO	Define 'visibility'.	x	x	x	x	x	x
LO	Describe the meteorological measurement of visibility.	x	x	x	x	x	x
LO	Define 'prevailing visibility'.	x	x	x	x	x	x
LO	Define 'ground visibility'.	x	x	x	x	x	x
LO	List the units used for visibility (m, km).	x	x	x	x	x	x
LO	Define 'runway visual range'.	x	x	x	x	x	x
LO	Describe the meteorological measurement of runway visual range.	x	x	x	x	x	x
LO	Indicate where the transmissometers/ forward-scatter meters are placed on the airport.	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	List the units used for runway visual range (m).	x	x	x	x	x	x
LO	List the different possibilities to transmit information to pilots about runway visual range.	x	x	x	x	x	x
LO	Compare visibility and runway visual range.	x	x	x	x	x	x
LO	Indicate the means of observation of present weather.	x	x	x	x	x	x
LO	Indicate the means of observing clouds: type, amount, height of base (ceilometers) and top.	x	x	x	x	x	x
LO	List the clouds considered in meteorological reports, and how they are indicated in METARs (TCU, CB).	x	x	x	x	x	x
LO	Define ‘oktas’.	x	x	x	x	x	x
LO	Define ‘cloud base’.	x	x	x	x	x	x
LO	Define ‘ceiling’.	x	x	x	x	x	x
LO	Name the unit and the reference level used for information about cloud base (ft).	x	x	x	x	x	x
LO	Define ‘vertical visibility’.	x	x	x	x	x	x
LO	Explain briefly how and when vertical visibility is measured.	x	x	x	x	x	x
LO	Name the unit used for vertical visibility (ft).	x	x	x	x	x	x
LO	Indicate the means of observation of air temperature (thermometer).	x	x	x	x	x	x
LO	List the units used for air temperature (Celsius, Fahrenheit, Kelvin). *(Refer to 050 01 02 01)*	x	x	x	x	x	x
LO	Indicate the means of observation of relative humidity (hygrometer and psychrometer) and dew-point temperature (calculation).	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Name the units of relative humidity (%) and dew-point temperature (Celsius, Fahrenheit).	x	x	x	x	x	x
LO	Indicate the means of observation of atmospheric pressure (mercury and aneroid barometer).	x	x	x	x	x	x
LO	List the units of atmospheric pressure (hPa, inches). *(Refer to 050 01 03 01)*	x	x	x	x	x	x
050 10 01 02	**Radiosonde observations**						
LO	Describe the principle of radiosondes.	x	x	x	x	x	x
LO	Describe and interpret the sounding by radiosonde given on a simplified T-P diagram.	x	x	x	x	x	x
050 10 01 03	**Satellite observations**						
LO	Describe the basic outlines of satellite observations.	x	x	x	x	x	x
LO	Name the main uses of satellite pictures in aviation meteorology.	x	x	x	x	x	x
LO	Describe the different types of satellite imagery.	x	x	x	x	x	x
LO	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
LO	Interpret qualitatively the satellite pictures in order to get useful information for the flights: — location of fronts.	x	x	x	x	x	x
LO	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)***						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe the basic principle and the type of information given by a ground weather radar.	x	x	x	x	x	x
LO	Interpret ground weather radar images.	x	x	x	x	x	x
LO	Describe the basic principle and the type of information given by airborne weather radar.	x	x	x	x	x	x
LO	Describe the limits and the errors of airborne weather radar information.	x	x	x	x	x	x
LO	Interpret typical airborne weather radar images.	x	x	x	x	x	x
050 10 01 05	**Aircraft observations and reporting**						
LO	Describe routine air report and special air report.	x	x	x	x	x	x
LO	State the obligation of a pilot to prepare air reports.	x	x	x	x	x	x
LO	Name the weather phenomena to be stated in a special air report.	x	x	x	x	x	x
050 10 02 00	**Weather charts**						
050 10 02 01	**Significant weather charts**						
LO	Decode and interpret significant weather charts (low, medium and high level).	x	x	x	x	x	x
LO	Describe from a significant weather chart the flight conditions at designated locations and/or along a defined flight route at a given flight level.	x	x	x	x	x	x
050 10 02 02	**Surface charts**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	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
LO	Determine from surface weather charts the wind direction and speed.	x	x	x	x	x	x
050 10 02 03	**Upper-air charts**						
LO	Define ‘constant-pressure chart’.	x	x	x	x	x	x
LO	Define ‘isohypse (contour line)’. *(Refer to 050 01 03 02)*	x	x	x	x	x	x
LO	Define ‘isotherm’.	x	x	x	x	x	x
LO	Define ‘isotach’.	x	x	x	x	x	x
LO	Describe forecast upper-wind and temperature charts.	x	x	x	x	x	x
LO	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	Name the most common flight levels corresponding to the constant pressure charts.	x	x	x	x	x	x
050 10 03 00	**Information for flight planning**						
050 10 03 01	**Aviation weather messages**						
LO	Describe, decode and interpret the following aviation weather messages (given in written and/or graphical format): METAR, SPECI, TREND, TAF, SIGMET, AIRMET, GAMET, special air report, volcanic ash advisory information.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe, decode and interpret the tropical cyclone advisory information in written and graphical form.	x		x	x		
LO	Describe the general meaning of MET REPORT and SPECIAL REPORT.	x	x	x	x	x	x
LO	List, in general, the cases when a SIGMET and an AIRMET are issued.	x	x	x	x	x	x
LO	Describe, decode (by using a code table) and interpret the following messages: Runway State Message (as written in a METAR), GAFOR. *rEMARK: For Runway State Message and GAFOR, refer to the Air Navigation Plan European Region Doc 7754.*	x	x	x	x	x	x
050 10 03 02	**Meteorological broadcasts for aviation**						
LO	Describe the meteorological content of broadcasts for aviation:						
	— VOLMET, ATIS;	x	x	x	x	x	x
	— HF-VOLMET.	x		x	x		
050 10 03 03	**Use of meteorological documents**						
LO	Describe meteorological briefing and advice.	x	x	x	x	x	x
LO	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
LO	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
050 10 03 04	**Meteorological warnings**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe and interpret aerodrome warnings and wind-shear warnings and alerts.	x	x	x	x	x	x
050 10 04 00	**Meteorological services**						
050 10 04 01	**World area forecast system and meteorological offices**						
LO	Name the main objectives of the world area forecast system: — world area forecast centres (upper-air forecasts).	x	x	x	x	x	x
LO	Name the main objectives of the world area forecast system: — meteorological offices (aerodrome forecasts, briefing documents).	x	x	x	x	x	x
LO	Name the main objectives of the world area forecast system: — meteorological watch offices (SIGMET, AIRMET).	x	x	x	x	x	x
LO	Name the main objectives of the world area forecast system: — aeronautical meteorological stations (METAR, MET reports).	x	x	x	x	x	x
LO	Name the main objectives of the world area forecast system: — volcanic ash advisory centres.	x	x	x	x	x	x
LO	Name the main objectives of the world area forecast system: — tropical cyclone advisory centres.	x		x	x		
050 10 04 02	**International organisations**						
LO	Describe briefly the following organisations and their chief activities: — International Civil Aviation Organization (ICAO) *(Refer to subject 010);* — World Meteorological Organization (WMO).	x	x	x	x	x	x

J. SUBJECT 061 — GENERAL NAVIGATION

For the purposes of theoretical-knowledge examinations, orthomorphic and conformal charts are taken as being the same type of chart.

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		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	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	
LO	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	
LO	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	
LO	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	
LO	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	
LO	Explain in which direction the Earth rotates on its axis.	x	x	x	x	x	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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	
LO	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	
LO	Explain that the Earth completes one orbit around the Sun in approximately 365,25 days.	x	x	x	x	x	
LO	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	
LO	Define the terms 'apparent Sun' and 'mean Sun' and state their relationship.	x	x	x	x	x	
LO	Define the 'celestial equator'. It is the projection of the Earth's equator onto the celestial sphere.	x	x	x	x	x	
LO	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	
LO	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	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Define the 'polar circles', the 'tropic of Cancer' and the 'tropic of Capricorn'.	x	x	x	x	x	
LO	Explain summer and winter solstice.	x	x	x	x	x	
LO	Explain the terms 'spring and autumn equinox'.	x	x	x	x	x	
LO	Explain at which time of the year the duration of daylight changes at the highest rate.	x	x	x	x	x	
LO	Explain the relationship between the declination of the Sun, latitude and the period of daylight.	x	x	x	x	x	
LO	State that the perihelion occurs early January and aphelion occurs early July.	x	x	x	x	x	
LO	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	
LO	Define 'zenith'. The point on the sky vertically overhead an observer.	x	x	x	x	x	
061 01 02 00	**The Earth**						
061 01 02 01	**Great circle, small circle, rhumb line**						
LO	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	
LO	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	
LO	State that the Earth may be described as an 'ellipsoid' or 'oblate spheroid'.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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	
LO	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	
LO	Define a 'great circle' in relation to the surface of a sphere.	x	x	x	x	x	
LO	Describe the 'geometric properties' of a great circle, including vertex.	x	x	x	x	x	
LO	Define a 'small circle' in relation to the surface of a sphere.	x	x	x	x	x	
LO	Define a 'rhumb line'. A line which cuts all meridians at the same angle.	x	x	x	x	x	
061 01 02 02	**Convergency, conversion angle**						
LO	Explain the term 'convergency of meridians' between two positions.	x	x	x	x	x	
LO	Explain how the value of convergency can be determined using calculation.	x	x	x	x	x	
LO	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	
LO	Calculate the value of convergency between two stated positions.	x	x	x	x	x	
LO	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	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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	
LO	Explain how the value of conversion angle can be calculated as half the value of convergency.	x	x	x	x	x	
LO	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	
061 01 02 03	**Latitude, difference of latitude**						
LO	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	
LO	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	
LO	State that the maximum difference between geographic and geocentric latitude occurs at altitude of 45 degrees.	x	x	x	x	x	
LO	Describe a parallel of latitude as a small circle connecting all positions on the Earth with the same latitude.	x	x	x	x	x	
LO	Calculate the difference of latitude between two given positions lat/long.	x	x	x	x	x	
LO	State that the 1-degree difference of latitude equals 60 nautical miles.	x	x	x	x	x	
LO	Convert the difference of latitude to distance.	x	x	x	x	x	
LO	Calculate the mean latitude between two positions.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
061 01 02 04	**Longitude, difference of longitude**						
LO	Describe a meridian as a semigreat circle, which runs north and south from pole to pole.	x	x	x	x	x	
LO	Explain that the meridians and their anti-meridian complete a great circle.	x	x	x	x	x	
LO	State that the Greenwich meridian is also known as the prime meridian.	x	x	x	x	x	
LO	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	
LO	Explain that the Greenwich anti-meridian is the maximum longitude possible, namely 180° east–west.	x	x	x	x	x	
LO	Calculate the difference of longitude between two given positions lat/long.	x	x	x	x	x	
LO	Name examples of great circles on the surface of the Earth.	x	x	x	x	x	
LO	Name examples of small circles on the surface of the Earth.	x	x	x	x	x	
LO	Define a ‘rhumb line’. A line intersecting all meridians at the same angle.	x	x	x	x	x	
LO	Explain the geometrical properties of a rhumb line. Parallels and meridians are special cases of rhumb lines.	x	x	x	x	x	
061 01 02 05	**Use of latitude and longitude coordinates to locate any specific position**						
LO	Explain that along the equator a difference of longitude of 1° equals a distance of 60 NM.	x	x	x	x	x	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain that because the meridians converge towards the poles, the distance between meridians will decrease with increase in latitude.	x	x	x	x	x	
LO	State that the Earth's distance along a parallel of latitude is also known as departure.	x	x	x	x	x	
LO	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	
LO	Given a position lat/long, distances travelled north–south in NM/km and distances travelled east–west in NM/km along a parallel of latitude. Calculate the new position.	x	x	x	x	x	
LO	Given two positions on same meridian (or one on the anti-meridian), calculate the distance.	x	x	x	x	x	
061 01 03 00	**Time and time conversions**						
061 01 03 01	**Apparent time**						
LO	Explain the principles of zone time.	x	x	x	x	x	
LO	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	
LO	Define and explain the term 'transit'. Explain that transit means that a celestial body crosses the observer's meridian.	x	x	x	x	x	
LO	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	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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	
LO	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	
LO	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	
LO	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	
LO	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	
LO	State that in order to have a constant measurement of time, which will still have the solar day as a basis, the average length of an apparent solar day is taken. This average day is called mean solar day. It is divided into 24 hours of mean time.	x	x	x	x	x	
LO	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	
LO	State that the time between two successive transits of the mean Sun over a meridian is constant.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain that the difference between apparent time and mean time is defined as the 'equation of time'.	x	x	x	x	x	
LO	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	
LO	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	
LO	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	
LO	Illustrate the relationship between time and arc along the equator.	x	x	x	x	x	
LO	Deduce conversion values for arc to time and visa versa.	x	x	x	x	x	
061 01 03 02	**Universal Time Coordinated (UTC)**						
LO	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	
LO	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	
LO	State that the conversion factor between LMT and UTC is arc (change of longitude) converted to time.	x	x	x	x	x	
LO	Convert arc to time.	x	x	x	x	x	
LO	Convert time to arc.	x	x	x	x	x	
LO	Convert between UTC and LMT.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
061 01 03 03	**Local Mean Time (LMT)**						
LO	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	
LO	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	
LO	State that the LMT at locations at different longitudes varies by an amount corresponding to the change in longitude.						
061 01 03 04	**Standard times (STs)**						
LO	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	
LO	State that some countries use summer time (daylight saving time).	x	x	x	x	x	
LO	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	
LO	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	
061 01 03 05	**Dateline**						
LO	Explain the effect on the LMT when approaching the 180° meridian line from either side.	x	x	x	x	x	
LO	State that the dateline does not follow exactly the 180° east–west meridian.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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	
LO	State that the dateline is the actual place where the change is made and, although mainly at the 180° meridian, there are some slight divergences in order to avoid countries being divided by the dateline.	x	x	x	x	x	
LO	State that when calculating times, the dateline is automatically taken into account by doing all conversions via UTC.	x	x	x	x	x	
LO	Calculate conversions of LMT and GMT/UTC and ST for cases involving the international dateline.	x	x	x	x	x	
061 01 03 06	**Determination of sunrise (SR), sunset (SS) and civil twilight**						
LO	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	
LO	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	
LO	Explain that SR will occur earlier and SS will occur later with increase in altitude.	x	x	x	x	x	
LO	State that the times for SR and SS given in the air almanac are calculated for the Greenwich meridian.	x	x	x	x	x	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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	
LO	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 same latitude, SR or SS will occur at approximately the same LMT.	x	x	x	x	x	
LO	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	
LO	State that SR and SS times are tabulated against specified dates and latitudes.	x	x	x	x	x	
LO	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	
LO	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	
LO	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	
LO	Explain the meaning of the term 'twilight'.	x	x	x	x	x	
LO	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	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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	
LO	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	
LO	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	
LO	Determine the duration of morning and evening civil twilight.	x	x	x	x	x	
LO	Explain the effect of declination and latitude on the duration of twilight.	x	x	x	x	x	
061 01 04 00	**Directions**						
061 01 04 01	**True north**						
LO	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	
LO	State that true directions are measured clockwise as an angle in degrees from true north (TN).	x	x	x	x	x	
061 01 04 02	**Terrestrial magnetism: magnetic north, inclination and variation**						
LO	State that a freely suspended compass needle will turn to the direction of the local magnetic field. The direction of the horizontal component of this field is the direction of magnetic north (MN).	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that the magnetic poles do not coincide with the geographic poles.	x	x	x	x	x	
LO	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	
LO	Define 'magnetic dip or inclination'. The angle between the horizontal and the total component of the magnetic field.	x	x	x	x	x	
LO	State that the angle of inclination at the magnetic poles is 90°.	x	x	x	x	x	
LO	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	
LO	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	
061 01 04 03	**Compass deviation, compass north**						
LO	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 the magnetic field of the aircraft.	x	x	x	x	x	
LO	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	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that the angle between magnetic north and compass north is called deviation (DEV) and is given in degrees east (+ or E) or west (– or W) of the magnetic north.	x	x	x	x	x	
LO	State that deviation is kept to a minimum by compass swinging.	x	x	x	x	x	
061 01 04 04	**Isogonals, relationship between true and magnetic north**						
LO	State that the angle between the true north and magnetic north is called variation (VAR) being measured in degrees east (+ or E) or west (– or W) of the true north.	x	x	x	x	x	
LO	Define an 'isogonal line'. A line joining positions of equal variation.	x	x	x	x	x	
LO	Convert between compass, magnetic and true directions.	x	x	x	x	x	
061 01 04 05	**Gridlines, isogrives**						
LO	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		
LO	Explain that the gridlines or the grid meridians are drawn on the chart parallel to the reference meridian.	x		x	x		
LO	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		
LO	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		

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that a line joining points, which have the same grivation, is called an isogriv.	x		x	x		
LO	Convert between compass, magnetic, true and grid directions.	x		x	x		
061 01 05 00	**Distance**						
061 01 05 01	**Units of distance and height used in navigation: nautical miles, statute miles, kilometres, metres, feet**						
LO	Define the 'nautical mile'. A distance being equal to 1 852 km.	x	x	x	x	x	
LO	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	
LO	State that when dealing with heights and altitudes the unit used is metres or feet subject to the choice of individual States.	x	x	x	x	x	
061 01 05 02	**Conversion from one unit to another**						
LO	Convert between the following units: nautical miles (NM), statute miles (SM), kilometres (km), metres (m) and feet (ft).	x	x	x	x	x	
061 01 05 03	**Relationship between nautical miles and minutes of latitude and minutes of longitude**						
LO	State that horizontal distances are calculated in metres, kilometres and nautical miles.	x	x	x	x	x	
LO	Given two positions or latitude/longitude difference, calculate the distance.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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	
LO	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	
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**						
LO	Direct-reading compass (DRC).	x	x	x	x	x	
LO	Interpret the indications on a DRC, given an indication on the compass, deviation or deviation table and variation.	x	x	x	x	x	
061 02 01 02	**Serviceability tests**						
LO	State the pre-flight serviceability check of the DRC, such as: — general condition; — check indication is within the limits.	x	x	x	x	x	
LO	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	
LO	State that the compass should be checked when carrying magnetic freight or freight with a large ferrous metal content.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
061 02 01 03	**Situations requiring a compass swing**						
LO	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; — when a new compass is fitted; — at any time when the compass or recorded deviation is suspect; — when specified in the aircraft maintenance schedule.	x	x	x	x	x	
061 03 00 00	**CHARTS**						
061 03 01 00	**General properties of miscellaneous types of projections**						
LO	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	
LO	State that on a conformal chart the angles measured on the chart are the same as on the Earth.	x	x	x	x	x	
LO	State that different chart projections are used, depending on the application and area of use involved.	x	x	x	x	x	
LO	State that all charts, although they have been developed mathematically, are designated as projections.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that the following projection surfaces are used when projecting charts: — plane, — cylindrical, — conical.	x	x	x	x	x	
LO	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	
LO	Use the scale of a chart to calculate particular distances.	x	x	x	x	x	
LO	Calculate scale given chart length and Earth distance.	x	x	x	x	x	
LO	Define the term 'chart convergency'. The angle between two given meridians on the chart.	x	x	x	x	x	
LO	Define 'parallel of origin'. The parallel where the projection surface touches the surface of the reduced Earth.	x	x	x	x	x	
061 03 01 01	**Direct Mercator**						
LO	State that the direct Mercator is a cylindrical projection. The parallel of origin is the equator.	x	x	x	x	x	
LO	State that the convergency on the chart is 0°.	x	x	x	x	x	
LO	State that the scale increases with increasing distance from the equator.	x	x	x	x	x	
LO	State that on a direct Mercator: scale at any latitude = scale at the equator × secant latitude (1/cosine latitude).	x	x	x	x	x	
LO	Given the scale at one latitude, calculate the scale at different latitudes.	x	x	x	x	x	
LO	Given a chart length at one atitude, show that it represents a different Earth distance at other latitudes.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
061 03 01 02	**Lambert conformal conic**						
LO	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	
LO	Define the term 'standard parallel'. The latitudes where the cone cuts the reduced Earth.	x	x	x	x	x	
LO	State that at the parallel of origin, Earth convergency is equal to chart convergency.	x	x	x	x	x	
LO	State that the parallel of origin is close to the mean latitude between the standard parallels.	x	x	x	x	x	
LO	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	
LO	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	
LO	Chart convergency = difference of longitude × constant of cone.	x	x	x	x	x	
LO	Given appropriate data, calculate initial, final or rhumb-line tracks between two positions (lat/long).	x	x	x	x	x	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Given two positions (lat/long) and information to determine convergency between the two positions, calculate the parallel of origin.	x	x	x	x	x	
LO	Given a Lambert chart, determine the parallel of origin, or constant of cone.	x	x	x	x	x	
LO	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	
061 03 01 03	**Polar stereographic**						
LO	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		
LO	State that chart convergency = difference of longitude.	x		x	x		
LO	State that the scale is increasing with increasing distance from the pole.	x		x	x		
LO	Given two positions (lat/long), rhumb-line true track or initial/final great-circle true track, calculate the missing track angles.	x		x	x		
LO	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		
061 03 02 00	**The representation of meridians, parallels, great circles and rhumb lines**						
061 03 02 01	**Direct Mercator**						
LO	State that meridians are straight parallel lines, which cut parallels of latitudes at right angles.	x	x	x	x	x	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that parallels of latitude are straight lines parallel to the equator.	x	x	x	x	x	
LO	State that a straight line on the chart is a rhumb line.	x	x	x	x	x	
LO	State that the great circle is a line convex to the nearest pole.	x	x	x	x	x	
LO	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 mean latitude.	x	x	x	x	x	
LO	Given rhumb-line true track between two positions (lat/long), calculate initial or final great-circle true track.	x	x	x	x	x	
061 03 02 02	**Lambert conformal conic**						
LO	State that meridians are straight lines, which cut parallels of latitudes at right angles.	x	x	x	x	x	
LO	State that parallels of latitude are arcs of concentric circles.	x	x	x	x	x	
LO	State that great circles are curved lines concave towards the parallels of origin.	x	x	x	x	x	
LO	State that for short distances the great circle is approximately a straight line.	x	x	x	x	x	
061 03 02 03	**Polar stereographic**						
LO	State that meridians are straight lines radiating from the pole, which cut parallels of latitudes at right angles.	x		x	x		
LO	State that parallels of latitude are concentric circles, and in this projection the distance apart increases away from the pole.	x		x	x		

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that great circles are approximately straight lines close to the pole. The exact great circle being concave to the pole.	x		x	x		
061 03 03 00	**The use of current aeronautical charts**						
061 03 03 01	**Plotting positions**						
LO	Enter the position on a chart using range and bearing from a VOR DME station, and derive geographical coordinates.	x	x	x	x	x	
LO	Enter the positions on a chart using geographical coordinates and derive tracks and distances.	x	x	x	x	x	
LO	Plot DME ranges on an aeronautical chart and derive geographical coordinates.	x	x	x	x	x	
LO	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	
061 03 03 02	**Methods of indicating scale and relief**						
LO	Describe the methods of representing relief and demonstrate the ability to interpret data.	x	x	x	x	x	
061 03 03 03	**Conventional signs**						
LO	Interpret conventional signs and symbols on ICAO and other most frequently used charts.	x	x	x	x	x	
061 03 03 04	**Measuring tracks and distances**						
LO	Given two positions, measure the track and the distance between them.	x	x	x	x	x	
061 03 03 05	**Plotting bearings**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Resolve bearings of an NDB station for plotting on an aeronautical chart.	x	x	x	x	x	
LO	Resolve radials from VOR stations for plotting on an aeronautical chart.	x	x	x	x	x	
061 04 00 00	**DEAD RECKONING (DR) NAVIGATION**						
061 04 01 00	**Basis of dead reckoning**						
LO	Explain the triangle of velocities, e.g. true heading/TAS, W/V, and true track/GS.	x	x	x	x	x	
061 04 01 01	**Track**						
LO	Explain the concept of vectors including adding together or splitting in two directions.	x	x	x	x	x	
061 04 01 02	**Heading (compass, magnetic, true, grid)**						
LO	Calculate (compass, magnetic, true, grid) heading from given appropriate data.	x	x	x	x	x	
061 04 01 03	**Wind velocity**						
LO	Calculate wind velocity from given appropriate data.	x	x	x	x	x	
061 04 01 04	**Airspeed (IAS, CAS, TAS, Mach number)**						
LO	Calculate TAS from IAS/CAS and Mach number from given appropriate data.	x	x	x	x	x	
061 04 01 05	**Ground speed**						
LO	Calculate ground speed from given appropriate data.	x	x	x	x	x	
061 04 01 06	**ETA**						
LO	Calculate ETA, flying time from distance, and GS.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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	
061 04 01 07	**Drift, wind correction angle**						
LO	Calculate drift and wind correction angle from given appropriate data.	x	x	x	x	x	
061 04 02 00	**Use of the navigational computer**						
061 04 02 01	**Speed**						
LO	Given appropriate data, determine speed.	x	x	x	x	x	
061 04 02 02	**Time**						
LO	Given appropriate data, determine time.	x	x	x	x	x	
061 04 02 03	**Distance**						
LO	Given appropriate data, determine distance.	x	x	x	x	x	
061 04 02 04	**Fuel consumption**						
LO	Calculation of fuel used/fuel flow/flying time.	x	x	x	x	x	
061 04 02 05	**Conversions**						
LO	Conversion between kilograms/ pounds/litres/U.S. gallons/imperial gallons.	x	x	x	x	x	
LO	Conversion of distances. Kilometres/nautical miles/statute miles.	x	x	x	x	x	
LO	Conversion of distances. Feet/metres.	x	x	x	x	x	
LO	Conversion of volumes and weight of fuel using density in mass per unit volume.	x	x	x	x	x	
061 04 02 06	**Airspeed**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Calculation of airspeed problems including IAS/EAS/CAS/TAS/ and Mach number from given appropriate data.	x	x	x	x	x	
061 04 02 07	**Wind velocity**						
LO	Given appropriate data, determine wind velocity.	x	x	x	x	x	
061 04 02 08	**True altitude**						
LO	Given appropriate data, determine true altitude/indicated altitude/ density altitude.	x	x	x	x	x	
061 04 03 00	**The triangle of velocities**						
LO	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	
061 04 04 00	**Determination of DR position**						
061 04 04 01	**Confirmation of flight progress (DR)**						
LO	Describe the role and purpose of DR navigation.	x	x	x	x	x	
LO	Demonstrate mental DR techniques.	x	x	x	x	x	
LO	Define 'speed factor'. Speed divided by 60, used for mental flight-path calculations.	x	x	x	x	x	
LO	Calculate head/tailwind component.	x	x	x	x	x	
LO	Calculate wind correction angle (WCA) using the formula: WCA = XWC (crosswind component)/SF (speed factor)	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Distance, speed and time calculations.	x	x	x	x	x	
LO	Demonstrate DR position graphically and by means of a DR computer.	x	x	x	x	x	
LO	Given any four of the parts of the triangle of velocities, calculate the other two.	x	x	x	x	x	
LO	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	
061 04 04 02	**Lost procedures**						
LO	Describe course of action when lost.	x	x	x	x	x	
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	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	
LO	Calculate indicated altitude from given T ALT, airfield elevation, SAT/OAT and QNH/QFE.	x	x	x	x	x	
LO	Calculate density altitude from given pressure altitude and SAT/OAT.	x	x	x	x	x	
LO	Calculate density altitude from given airfield elevation, SAT/OAT and QNH/QFE.	x	x	x	x	x	
061 04 05 02	**Determination of temperature**						
LO	Define 'OAT/SAT'. The temperature of the surrounding air.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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	
LO	Define 'ram rise'. The increase of temperature at the temperature probe due to friction and compressibility.	x	x	x	x	x	
LO	RAT (TAT, IOAT) = OAT (SAT) + ram rise.	x	x	x	x	x	
LO	Explain the difference in using OAT/SAT compared to RAT/TAT/IOAT in airspeed calculations.	x	x	x	x	x	
061 04 05 03	**Determination of appropriate speed**						
LO	Explain the relationship between: — IAS, — CAS, — EAS, — and TAS.	x	x	x	x	x	
LO	Calculate TAS from given IAS/CAS, OAT/SAT and pressure inputs.	x	x	x	x	x	
LO	Calculate CAS from given TAS, OAT/SAT and pressure inputs.	x	x	x	x	x	
061 04 05 04	**Determination of Mach number**						
LO	Calculate Mach number from given TAS and OAT/SAT.	x	x	x	x	x	
061 05 00 00	**IN-FLIGHT NAVIGATION**						
061 05 01 00	**Use of visual observations and application to in-flight navigation**						
LO	Describe what is meant by the term 'map reading'.	x	x	x	x	x	
LO	Define the term 'visual checkpoint'.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Discuss the general features of a visual checkpoint and give examples.	x	x	x	x	x	
LO	State that the evaluation of the differences between DR positions and actual position can refine flight performance and navigation.	x	x	x	x	x	
LO	Establish fixes on navigational charts by plotting visually derived intersecting lines of position.	x	x	x	x	x	
LO	Describe the use of a single observed position line to check flight progress.	x	x	x	x	x	
LO	Describe how to prepare and align a map/chart for use in visual navigation.	x	x	x	x	x	
LO	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	
LO	Describe the action to be taken if there is no visual checkpoint available at a scheduled turning point.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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 detailed and accurate charted data.	x	x	x	x	x	
LO	State the function of contour lines on a topographical chart.	x	x	x	x	x	
LO	Indicate the role of 'layer tinting' (colour gradient) in relation to the depiction of topography on a chart.	x	x	x	x	x	
LO	Using the contours shown on a chart, describe the appearance of a significant feature.	x	x	x	x	x	
LO	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	
061 05 02 00	**Navigation in climb and descent**						
061 05 02 01	**Average airspeed**						
LO	Average TAS used for climb problems is calculated at the altitude 2/3 of the cruising altitude.	x	x	x	x	x	
LO	Average TAS used for descent problems is calculated at the altitude 1/2 of the descent altitude.	x	x	x	x	x	
061 05 02 02	**Average wind velocity (WV)**						
LO	WV used for climb problems is the WV at the altitude 2/3 of the cruising altitude.	x	x	x	x	x	
LO	WV used for descent problems is the WV at the altitude 1/2 of the descent altitude.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Calculate the average climb/descent GS from given TAS at various altitudes, WV at various altitudes and true track.	x	x	x	x	x	
LO	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	
LO	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	
LO	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	
LO	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	
LO	Given speed, distance to go and altitude to climb/descent, calculate the rate of climb/descent.	x	x	x	x	x	
LO	State the effect on TAS and Mach number when climbing/descending with a constant CAS.						
061 05 02 03	**Ground speed/distance covered during climb or descent**						
LO	State that most Aircraft Operating Handbooks supply graphical material to calculate climb and descent problems.	x	x	x	x	x	
LO	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	
LO	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	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
061 05 02 04	**Gradients versus rate of climb/descent**						
LO	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	
LO	Gradient in % = altitude difference (feet) × 100 / ground difference (feet).	x	x	x	x	x	
LO	Gradient in degrees = Arctg (Altitude difference (feet) / ground distance (feet)).	x	x	x	x	x	
LO	Rate of climb/descent (feet/min) = gradient (%) × GS (kt).	x	x	x	x	x	
LO	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	
061 05 03 00	**Navigation in cruising flight, use of fixes to revise navigation data**						
061 05 03 01	**Ground-speed revision**						
LO	Calculate revised ground speed to reach a waypoint at a specific time.	x	x	x	x	x	
LO	Calculate the average ground speed based on two observed fixes.	x	x	x	x	x	
LO	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	
061 05 03 02	**Off-track corrections**						
LO	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	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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	
LO	Calculate the average drift angle based upon an off-course fix observation.	x	x	x	x	x	
061 05 03 03	**Calculation of wind speed and direction**						
LO	Calculate the average wind speed and direction based on two observed fixes.	x	x	x	x	x	
061 05 03 04	**Estimated Time of Arrival (ETA) revisions**						
LO	Calculate ETA revisions based upon observed fixes and revised ground speed.	x	x	x	x	x	
061 05 04 00	**Flight log**						
LO	Given relevant flight-plan data, calculate the missing data.	x	x	x	x	x	
LO	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	
LO	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	

K. SUBJECT 062 — RADIO NAVIGATION

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		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**						
LO	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
LO	Define 'cycle'. A complete series of values of a periodical process.	x	x	x	x	x	x
LO	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**						
LO	Define 'frequency'. The number of cycles occurring in 1 second in a radio wave expressed in Hertz (Hz).	x	x	x	x	x	x
LO	Define 'wavelength'. The physical distance travelled by a radio wave during one cycle of transmission.	x	x	x	x	x	x
LO	Define 'amplitude'. The maximum deflection in an oscillation or wave.	x	x	x	x	x	x
LO	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
LO	Define 'phase'. The fraction of one wavelength expressed in degrees from 000° to 360°.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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**						
LO	List the bands of the frequency spectrum for electromagnetic waves: — Very Low Frequency (VLF): 3–30 kHz; — Low Frequency (LF): 30–300 kHz; — Medium Frequency (MF): 300–3 000 kHz; — High Frequency (HF): 3–30 MHz; — Very High Frequency (VHF): 30–300 MHz; — Ultra High Frequency (UHF): 300–3 000 MHz; — Super High Frequency (SHF): 3–30 GHz; — Extremely High Frequency (EHF): 30–300 GHz.	x	x	x	x	x	x
LO	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
LO	State that HF VOLMET and HF two-way communication use a single sideband.	x	x	x	x	x	x
LO	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

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
062 01 01 04	**Pulse characteristics**						
LO	Define the following terms as associated with a pulse string: — pulse length, — pulse power, — continuous power.	x	x	x	x	x	x
062 01 01 05	**Carrier, modulation**						
LO	Define 'carrier wave'. The radio wave acting as the carrier or transporter.	x	x	x	x	x	x
LO	Define 'keying'. Interrupting the carrier wave to break it into dots and dashes.	x	x	x	x	x	x
LO	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)**						
LO	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
LO	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
LO	Describe 'pulse modulation'. A modulation form used in radar by transmitting short pulses followed by larger interruptions.	x	x	x	x	x	x
LO	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**						
LO	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

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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	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
LO	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
LO	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
LO	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	State that the electric field is parallel to the wire and the magnetic field is perpendicular to it.	x	x	x	x	x	x
062 01 02 02	**Polarisation**						
LO	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
LO	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
LO	Explain the difference between horizontal and vertical polarisation in the dependence of the alignment of the dipole.	x	x	x	x	x	x
062 01 02 03	**Types of antennas**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	List and describe the common different kinds of directional antennas: — loop antenna used in old 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
062 01 03 00	**Wave propagation**						
062 01 03 01	**Structure of the ionosphere**						
LO	State that the ionosphere is the ionised component of the Earth’s upper atmosphere from 60 to 400 km above the surface, which is vertically structured in three regions or layers.	x	x	x	x	x	x
LO	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
LO	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**						
LO	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**						
LO	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**						
LO	State that radio waves in VHF, UHF, SHF and EHF propagate as space waves.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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**						
LO	State that Doppler effect is the phenomenon that the frequency of an electromagnetic wave will increase or decrease if there is relative motion between the transmitter and the receiver.	x	x	x	x	x	x
LO	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
062 01 03 06	**Factors affecting propagation**						
LO	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	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
LO	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
LO	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
LO	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 D/F**						
062 02 01 01	**Principles**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Describe the use of a Ground Direction Finder.	x	x	x	x	x	x
LO	Explain why the service provided is subdivided as: - VHF direction finding (VDF) - UHF direction finding (UDF).	x	x	x	x	x	x
LO	Explain the limitation of range because of the path of the VHF signal.	x	x	x	x	x	x
LO	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
062 02 01 02	**Presentation and interpretation**						
LO	Define the term 'QDM'. The magnetic bearing to the station.	x	x	x	x	x	x
LO	Define the term 'QDR'. The magnetic bearing from the station.	x	x	x	x	x	x
LO	Define the term 'QUJ'. The true bearing to the station.	x	x	x	x	x	x
LO	Define the term 'QTE'. The true bearing from the station.	x	x	x	x	x	x
LO	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
062 02 01 03	**Coverage and range**						
LO	Use the formula: $1.23 \times \sqrt{\text{transmitter height in feet}} + 1.23 \times \sqrt{\text{receiver height in feet}}$, to calculate the range in NM.	x	x	x	x	x	x
062 02 01 04	**Errors and accuracy**						
LO	Explain why synchronous transmissions will cause errors.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Describe the effect of 'multipath signals'.	x	x	x	x	x	x
LO	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-Directional Beacon (NDB)/ Automatic Direction Finder (ADF)**						
062 02 02 01	**Principles**						
LO	Define the acronym 'NDB'. Non-Directional Beacon.	x	x	x	x	x	x
LO	Define the acronym 'ADF'. Automatic Direction Finder.	x	x	x	x	x	x
LO	State that the NDB is the ground part of the system.	x	x	x	x	x	x
LO	State that the ADF is the airborne part of the system.	x	x	x	x	x	x
LO	State that the NDB operates in the LF and MF frequency bands.	x	x	x	x	x	x
LO	The frequency band assigned to aeronautical NDBs according to ICAO Annex 10 is 190–1 750 kHz.	x	x	x	x	x	x
LO	Define a 'locator beacon'. An LF/MF NDB used as an aid to final approach usually with a range, according to ICAO Annex 10, of 10–25 NM.	x	x	x	x	x	x
LO	Explain the difference between NDBs and locator beacons.	x	x	x	x	x	x
LO	Explain which beacons transmit signals suitable for use by an ADF.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that certain commercial radio stations transmit within the frequency band of the NDB.	x	x	x	x	x	x
LO	Explain why it is necessary to use a directionally sensitive receiver antenna system in order to obtain the direction of the incoming radio wave.	x	x	x	x	x	x
LO	Describe the use of NDBs for navigation.	x	x	x	x	x	x
LO	Describe the procedure to identify an NDB station.	x	x	x	x	x	x
LO	Interpret the term 'cone of silence' in respect of an NDB.	x	x	x	x	x	x
LO	State that an NDB station emits a NON/A1A or a NON/A2A signal.	x	x	x	x	x	x
LO	State the function of the Beat Frequency Oscillator (BFO).	x	x	x	x	x	x
LO	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
LO	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
LO	Explain that on modern aircraft the BFO is activated automatically.	x	x	x	x	x	x
062 02 02 02	**Presentation and interpretation**						
LO	Name the types of indicators in common use: — electronic navigation display; — Radio Magnetic Indicator (RMI); — fixed card ADF (radio compass); — moving card ADF.	x	x	x	x	x	x
LO	Describe the indications given on RMI, fixed card and moving card ADF displays.	x	x	x	x	x	x
LO	Given a display, interpret the relevant ADF information.	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Calculate the true bearing from the compass heading and relative bearing.	x	x	x	x	x	x
LO	Convert the compass bearing into magnetic bearing and true bearing.	x	x	x	x	x	x
LO	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
062 02 02 03	**Coverage and range**						
LO	State that the power limits the range of an NDB.	x	x	x	x	x	x
LO	Explain the relationship between power and range.	x	x	x	x	x	x
LO	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
LO	Describe the propagation path of NDB radio waves with respect to the ionosphere and the Earth's surface.	x	x	x	x	x	x
LO	Explain that interference between sky and ground waves at night leads to 'fading'.	x	x	x	x	x	x
LO	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
LO	State that there is no warning indication of NDB failure.	x	x	x	x	x	x
062 02 02 04	**Errors and accuracy**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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
LO	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
LO	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
LO	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
062 02 02 05	**Factors affecting range and accuracy**						
LO	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
LO	State that coastal refraction error increases with increased incidence.	x	x	x	x	x	x
LO	State that night effect predominates around dusk and dawn.	x	x	x	x	x	x
LO	Define 'multipath propagation of the radio wave (mountain effect)'.	x	x	x	x	x	x
LO	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
062 02 03 00	**VOR and Doppler VOR**						
062 02 03 01	**Principles**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain the operation of VOR using the following general terms: — reference phase; — variable phase; — phase difference.	x	x	x	x	x	x
LO	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
LO	State that frequencies within the allocated VOR range which have an odd number in the first decimal place, are used by ILS.	x	x	x	x	x	x
LO	State that the following types of VOR are in operation: — Conventional VOR (CVOR): a first-generation VOR station emitting signals by means of a rotating antenna; — Doppler VOR (DVOR): a second-generation VOR station emitting signals by means of a combination of fixed antennas utilising the Doppler principle; — en route VOR for use by IFR traffic; — Terminal VOR (TVOR): a station with a shorter range used as part of the approach and departure structure at major airports; — Test VOR (VOT): a VOR station emitting a signal to test VOR indicators in an aircraft.	x	x	x	x	x	x
LO	Describe how ATIS information is transmitted on VOR frequencies.	x	x	x	x	x	x
LO	List the three main components of VOR airborne equipment: — the antenna, — the receiver, — the indicator.	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Describe the identification of a VOR in terms of Morse-code letters, continuous tone or dots (VOT), tone pitch, repetition rate and additional plain text.	x	x	x	x	x	x
LO	State that according to ICAO Annex 10, a VOR station has an automatic ground monitoring system.	x	x	x	x	x	x
LO	State that the VOR monitoring system monitors change in measured radial and reduction in signal strength.	x	x	x	x	x	x
LO	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
062 02 03 02	**Presentation and interpretation**						
LO	Read off the radial on a Radio Magnetic Indicator (RMI).	x	x	x	x	x	x
LO	Read off the angular displacement in relation to a preselected radial on an HSI or CDI.	x	x	x	x	x	x
LO	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
LO	Interpret VOR information as displayed on HSI, CDI and RMI.	x	x	x	x	x	x
LO	Describe the following in-flight VOR procedures as in ICAO Doc 8168, Volume 1: — tracking, and explain the influence of wind when tracking; — interceptions; — procedural turns; — holding patterns.	x	x	x	x	x	x
LO	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

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
062 02 03 03	**Coverage and range**						
LO	Describe the range with respect to the transmitting power and radio signal.	x	x	x	x	x	x
LO	Calculate the range using the formula: 1.23 × √transmitter height in feet + 1.23 × √receiver height in feet.	x	x	x	x	x	x
062 02 03 04	**Errors and accuracy**						
LO	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
LO	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
LO	State that DVOR is less sensitive to site error than CVOR.	x	x	x	x	x	x
062 02 04 00	**DME**						
062 02 04 01	**Principles**						
LO	State that DME operates in the UHF band between 960–1215 MHz according to ICAO Annex 10.	x	x	x	x	x	x
LO	State that the system comprises two basic components: — the aircraft component, the interrogator; — the ground component, the transponder.	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Describe the principle of distance measurement using DME in terms of: — 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
LO	State that the distance measured by DME is slant range.	x	x	x	x	x	x
LO	Illustrate that a position line using DME is a circle with the station at its centre.	x	x	x	x	x	x
LO	Describe how 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
LO	Describe, in the case of co-location, the frequency pairing and identification procedure.	x	x	x	x	x	x
LO	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
LO	Explain that military TACAN stations may be used for DME information.	x	x	x	x	x	x
062 02 04 02	**Presentation and interpretation**						
LO	Explain that when identifying a DME station co-located with a VOR station, the identification signal with the higher-tone frequency is the DME which idents approximately every 40seconds.	x	x	x	x	x	x
LO	Calculate ground distance from given slant range and altitude.	x	x	x	x	x	x
LO	Describe the use of DME to fly a DME arc in accordance with ICAO Doc 8168, Volume 1.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that a DME system may have a ground speed read-out combined with the DME read-out.	x	x	x	x	x	x
062 02 04 03	**Coverage and range**						
LO	Explain why a ground station can generally respond to a maximum of 100 aircraft.	x	x	x	x	x	x
LO	Explain which aircraft will be denied a DME range first when more than 100 interrogations are being made.	x	x	x	x	x	x
062 02 04 04	**Errors and accuracy**						
LO	State that the error of the DME 'N' according to ICAO Annex 10 should not exceed $\pm$ 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
062 02 04 05	**Factors affecting range and accuracy**						
LO	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
LO	State that, close to the station, the ground speed read-out combined with DME is less than the actual ground speed.	x	x	x	x	x	x
062 02 05 00	**ILS**						
062 02 05 01	**Principles**						
LO	Name the three main components of an ILS: — the localiser (LLZ); — the glide path (GP); — range information (markers or DME).	x		x			x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State the site locations of the ILS components: — the localiser antenna should be located on the extension of the runway centre line at the stop-end; — The glide-path antenna should be located 300 metres beyond the runway threshold, laterally displaced approximately 120 metres to the side of the runway centre line.	x		x			x
LO	Explain that marker beacons produce radiation patterns to indicate predetermined distances from the threshold along the ILS glide path.	x		x			x
LO	Explain that marker beacons are sometimes replaced by a DME paired with the LLZ frequency.	x		x			x
LO	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
LO	State that the LLZ operates in the 108,0–111.975 MHz VHF band, according to ICAO Annex 10.	x		x			x
LO	State that the GP operates in the UHF band.	x		x			x
LO	Describe the use of the 90-Hz and the 150-Hz signals in the LLZ and GP transmitters/receivers, stating how the signals at the receivers vary with angular deviation.	x		x			x
LO	Draw the radiation pattern with respect to the 90-Hz and 150-Hz signals.	x		x			x
LO	Describe how the UHF glide-path frequency is selected automatically by being paired with the LLZ frequency.	x		x			x
LO	Explain the term 'Difference of Depth of Modulation (DDM)'.	x		x			x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that the difference in the modulation depth increases with displacement from the centre line.	x		x			x
LO	State that both the LLZ and the GP antenna radiate side lobes (false beams) which could give rise to false centre-line and false glide-path indication.	x		x			x
LO	Explain that the back beam from the LLZ antenna may be used as a published 'non-precision approach'.	x		x			x
LO	State that according to ICAO Annex 10 the nominal glide path is 3°.	x		x			x
LO	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 are: — outer marker: 400 Hz; — middle marker: 1 300 Hz; — inner marker: 3000 Hz. 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.	x		x			x
LO	State that according to ICAO Doc 8168, the final-approach area contains a fix or facility that permits verification of the ILS glide path–altimeter relationship. The outer marker or DME is usually used for this purpose.	x		x			x
062 02 05 02	**Presentation and interpretation**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Describe the ILS identification regarding frequency and Morse code and/or plain text.	x		x			x
LO	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
LO	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
LO	Interpret the markers by sound, modulation, and frequency.	x		x			x
LO	State that the outer-marker cockpit indicator is coloured blue, the middle marker amber, and the inner marker white.	x		x			x
LO	State that in accordance with ICAO Annex 10, an ILS installation has an automatic ground monitoring system.	x		x			x
LO	State that the LLZ and GP monitoring system monitors any shift in the LLZ and GP mean course line or reduction in signal strength.	x		x			x
LO	State that a failure of either the LLZ 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
LO	State that an ILS receiver has an automatic monitoring function.	x		x			x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Describe the circumstances in which warning flags will appear for both the LLZ and the GP: — absence of the carrier frequency; — absence of the 90 and 150-Hz modulation simultaneously; — the percentage modulation of either the 90 or 150-Hz signal reduced to 0.	x		x			x
LO	Interpret the indications on a Course Deviation Indicator (CDI) and a 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.	x		x			x
LO	Interpret the aircraft's position in relation to the extended runway centre line on a back-beam approach.	x		x			x
LO	Explain the setting of the course pointer of an HSI for front-beam and back-beam approaches.	x		x			x
062 02 05 03	**Coverage and range**						
LO	Sketch the standard coverage area of the LLZ and GP with angular sector limits in degrees and distance limits from the transmitter in accordance with ICAO Annex 10: — LLZ 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
062 02 05 04	**Errors and accuracy**						
LO	Explain that ILS approaches are divided into facility performance categories defined in ICAO Annex 10.	x		x			x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Define the following ILS operation categories: — Category I, — Category II, — Category IIIA, — Category IIIB, — Category IIIC.	x		x			x
LO	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
LO	Explain why the accuracy requirements are progressively higher for CAT I, CAT II and CAT III ILS.	x		x			x
LO	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
LO	Explain the following in accordance with ICAO Doc 8168: — the accuracy the pilot has to fly the ILS localiser 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 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.	x		x			x
LO	State that if a pilot deviates by more than half-scale deflection on the LLZ or by more than half-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

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Describe ILS beam bends. Deviations from the nominal position of the LLZ and GP respectively. They are ascertained by flight test.	x		x			x
LO	Explain multipath interference. Reflections from large objects within the ILS coverage area.	x		x			x
062 02 05 05	**Factors affecting range and accuracy**						
LO	Define the 'ILS-critical area'. An area of defined dimensions about the LLZ and GP antennas where vehicles, including aircraft, are excluded during all ILS operations.	x		x			x
LO	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	Describe the effect of FM broadcast stations that transmit on frequencies just below 108 MHz.	x		x			x
062 02 06 00	**Microwave Landing System (MLS)**						
062 02 06 01	**Principles**						
LO	Explain the principle of operation: — horizontal course guidance during the approach; — vertical guidance during the approach; — horizontal guidance for departure and missed approach; — DME (DME/P) distance; — transmission of special information regarding the system and the approach conditions.	x		x			x
LO	State that MLS operates in the S band on 200 channels.	x		x			x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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	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	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	Illustrate that segmented and curved approaches can only be executed with DME-P installed.	x		x			x
LO	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	Explain why MLS without DME-P gives an ILS lookalike straight-line approach.	x		x			x
062 02 06 03	**Coverage and range**						
LO	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	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**						

Syllabus reference	Syllabus details and associated Learning Objectives	_Aeroplane_		_Helicopter_			_IR_
		ATPL	CPL	ATPL /IR	ATPL	CPL	
062 03 01 00	**Pulse techniques and associated terms**						
LO	Name the different applications of radar with respect to ATC, MET observations and airborne weather radar.	x	x	x	x	x	x
LO	Describe the pulse technique and echo principle on which primary radar systems are based.	x	x	x	x	x	x
LO	Explain the relationship between the maximum theoretical range and the Pulse Repetition Frequency (PRF).	x	x	x	x	x	x
LO	Calculate the maximum theoretical unambiguous range if the PRF is given using the formula: $\text{Range in km} = \frac{300\,000}{\text{PRF} \times 2}$	x	x	x	x	x	x
LO	Calculate the PRF if the maximum theoretical unambiguous range of the radar is given using the formula: $\text{PRF} = \frac{300\,000}{\text{range (km)} \times 2}$	x	x	x	x	x	x
LO	Explain that pulse length defines the minimum theoretical range of a radar.	x	x	x	x	x	x
LO	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
LO	Describe, in general terms, the effects of the following factors with respect to the quality of the target depiction on the radar display: — atmospheric conditions: superrefraction and subrefraction; — attenuation with distance; — condition and size of the reflecting surface.	x	x	x	x	x	x
062 03 02 00	**Ground radar**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
062 03 02 01	**Principles**						
LO	Explain that primary radar provides bearing and distance of targets.	x		x	x		x
LO	Explain that primary ground radar is used to detect aircraft that are not equipped with a secondary radar transponder.	x		x	x		x
LO	Explain why Moving Target Indicator (MTI) is used.	x		x	x		x
062 03 02 02	**Presentation and interpretation**						
LO	State that modern ATC systems use computer-generated display.	x		x	x		x
LO	Explain that the radar display enables the ATS controller to provide information, surveillance or guidance service.	x		x	x		x
062 03 03 00	**Airborne weather radar**						
062 03 03 01	**Principles**						
LO	List the two main tasks of the weather radar in respect of weather and navigation.	x		x	x		x
LO	State the wavelength (approx. 3 cm) and frequency of most AWRs (approx. 9 GHz).	x		x	x		x
LO	Explain how the antenna is attitude-stabilised in relation to the horizontal plane using the aircraft's attitude reference system.	x		x	x		x
LO	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 weather (pencil/cone-shaped).	x		x	x		x
LO	Describe the cone-shaped pencil beam of about 3° to 5° beam width used for weather depiction.	x		x	x		x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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
062 03 03 02	**Presentation and interpretation**						
LO	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
LO	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
LO	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
062 03 03 03	**Coverage and range**						
LO	Explain how the radar is used for weather detection and for mapping (range, tilt and gain, if available).	x		x	x		x
062 03 03 04	**Errors, accuracy, limitations**						
LO	Explain why AWR should be used with extreme caution when on the ground.	x		x	x		x
062 03 03 05	**Factors affecting range and accuracy**						
LO	Explain the danger of the area behind heavy rain (shadow area) where no radar waves will penetrate.	x		x	x		x
LO	Explain why the tilt setting should be higher when the aircraft descends to a lower altitude.	x		x	x		x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain why the tilt setting should be lower when the aircraft climbs to a higher altitude.	x		x	x		x
LO	Explain why a thunderstorm may not be detected when the tilt is set too high.	x		x	x		x
062 03 03 06	**Application for navigation**						
LO	Describe the navigation function of the radar in the mapping mode.	x		x	x		x
LO	Describe the use of the weather radar to avoid a thunderstorm (Cb).	x		x	x		x
LO	Explain how turbulence (not CAT) can be detected by a modern weather radar.	x		x	x		x
LO	Explain how windshear can be detected by a modern weather radar.	x		x	x		x
062 03 04 00	**Secondary surveillance radar and transponder**						
062 03 04 01	**Principles**						
LO	Explain 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
LO	Explain 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
LO	Explain that an airborne transponder provides coded-reply signals in response to interrogation signals from the ground secondary radar and from aircraft equipped with TCAS.	x	x	x	x	x	x
LO	Explain the advantages of SSR over a primary radar.	x	x	x	x	x	x
062 03 04 02	**Modes and codes**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain that the interrogator transmits its interrogations in the form of a series of pulses.	x	x	x	x	x	x
LO	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
LO	State that the interrogation frequency is 1 030 MHz and the reply frequency is 1 090 MHz.	x	x	x	x	x	x
LO	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	x
LO	State that the ground interrogation signal is transmitted 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.	x	x	x	x	x	x
LO	Explain that the interval between P1 and P3 determines the mode of interrogation, Mode A or C.	x	x	x	x	x	x
LO	State that the radiated amplitude of P2 from the side lobes and from the main lobe is different.	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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
LO	State that in Mode-C reply the pressure altitude is reported in 100-ft increments.	x	x	x	x	x	x
LO	State that in addition to the information pulses provided, a Special Position Identification (SPI) pulse can be transmitted but only as a result of a manual selection (IDENT).	x	x	x	x	x	x
LO	Explain the need for compatibility of Mode S with Mode A and C.	x	x	x	x	x	x
LO	Explain that Mode-S transponders receive interrogations from other Mode-S transponders and SSR ground stations.	x	x	x	x	x	x
LO	State that Mode-S surveillance protocols implicitly use the principle of selective addressing.	x	x	x	x	x	x
LO	Explain that every aircraft will have been allocated an ICAO Aircraft Address which is hard-coded into the airframe (Mode-S address).	x	x	x	x	x	x
LO	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
LO	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
LO	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

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Interpret the following Mode-S terms: — selective addressing; — mode 'all call'; — selective call.	x	x	x	x	x	x
LO	State that Mode-S interrogation contains either: — aircraft address; — all call address; — broadcast address.	x	x	x	x	x	x
LO	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
LO	Mode A/C only all-call consists of 3 pulses: P1, P3 and the short P4.	x	x	x	x	x	x
LO	State that there are 25 possible Mode-S reply forms.	x	x	x	x	x	x
LO	State that the reply message consists of a preamble and a data block.	x	x	x	x	x	x
LO	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
LO	Explain that Mode S can provide enhanced vertical tracking, using a 25-feet altitude increment.	x	x	x	x	x	x
LO	Explain how SSR can be used for ADS B.	x	x	x	x	x	x
062 03 04 03	**Presentation and interpretation**						
LO	Explain how an aircraft can be identified by a unique code.	x	x	x	x	x	x
LO	Illustrate how the following information is presented on the radar screen: — pressure altitude; — flight level; — flight number or aircraft registration; — ground speed.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Name and interpret the codes 7700, 7600 and 7500.	x	x	x	x	x	x
LO	Interpret the selector modes: OFF, Standby, ON (mode A), ALT (mode A and C), and TEST.	x	x	x	x	x	x
LO	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
	ELEMENTARY SURVEILLANCE						
LO	Explain that the elementary surveillance provides the ATC controller with the aircraft's position, altitude and identification.	x	x	x	x	x	x
LO	State that the elementary surveillance needs Mode-S transponders with Surveillance Identifier (SI) code capacity and the automatic reporting of aircraft identification, known as ICAO Level 2s.	x	x	x	x	x	x
LO	State that the SI code must correspond to the aircraft identification specified in item 7 of the ICAO flight plan or to the registration marking.	x	x	x	x	x	x
LO	State that only the ICAO identification format is compatible with the ATS ground system.	x	x	x	x	x	x
LO	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
LO	Describe the different types of communication protocols (A, B, C and D).	x	x	x	x	x	x
LO	Explain that elementary surveillance is based on Ground-Initiated Comm-B protocols.	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	ENHANCED SURVEILLANCE						
LO	State that enhanced surveillance consists of the extraction of additional aircraft parameters known as Downlink Aircraft Parameters (DAP) consisting of: — magnetic heading; — indicated airspeed; — Mach number; — vertical rate; — roll angle; — track angle rate; — true track angle; — ground speed; — selected altitude.	x	x	x	x	x	x
LO	Explain that the 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
LO	Explain that the automatic extraction of an aircraft's parameters, and their presentation to the controller, will reduce their R/T workload and will free them to concentrate on ensuring the safe and efficient passage of air traffic.	x	x	x	x	x	x
LO	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
062 03 04 04	**Errors and accuracy**						
LO	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 and from the antenna; — 'fruiting' which results from the reception of replies caused by interrogations from other radar stations.	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
062 04 00 00	**INTENTONALLY LEFT BLANK**						
062 05 00 00	**AREA NAVIGATION SYSTEMS, RNAV/FMS**						
062 05 01 00	**General philosophy and definitions**						
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
LO	State that Basic RNAV (B-RNAV) systems require RNP 5.	x		x			x
LO	State that Precision RNAV (PRNAV) systems require RNP 1.	x		x			x
062 05 01 02	**Principles of 2D RNAV, 3D RNAV and 4D RNAV**						
LO	State that a 2D-RNAV system is able to navigate in the horizontal plane only.	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
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
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

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	The RNP type is based on the navigation performance accuracy to be achieved within anairspace.	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
LO	State that RNAV equipment is one requirement in order to receive approval to operate in an RNP environment.	x		x			x
LO	State that RNAV equipment operates by automatically determining the aircraft's position.	x		x			x
LO	State the advantages of using RNAV techniques over more conventional forms of navigation: — establishment of more direct routes permitting a reduction in flight distance; — establishment of dual or parallel routes to accommodate a greater flow of en route traffic; — establishment of bypass routes for aircraft overflying high-density terminal areas; — establishment of alternatives or contingency routes either on a planned or ad hoc basis; — establishment of optimum locations for holding patterns; — reduction in the number of ground navigation facilities.	x		x			x
LO	State that RNP may be specified for a route, a number of routes, an area, volume of airspace, or any airspace of defined dimensions.	x		x			x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that airborne navigation equipment uses inputs from navigational systems such as VOR/DME, DME/DME, GNSS, INS and IRS.	x		x			x
LO	State that aircraft equipped to operate to RNP 1 and better, should be able to compute an estimate of its position error, depending on the sensors being used and time elapsed.	x		x			x
LO	Indicate navigation-equipment failure.	x		x			x
062 05 02 00	**Simple 2D RNAV** *Info: First generation of radio-navigation systems 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 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
LO	Track guidance is shown on the HSI/CDI.	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
062 05 02 03	**Navigation computer input/output**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		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
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
LO	State that the system is limited to operate within the range of the selected VOR/DME station.	x		x			x
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.*						
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	x		x			x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	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; — 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 positional uncertainty, either as a quality factor or by						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	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); — 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.	x		x			x
LO	State that the navigational database is valid for a limited time, usually 28 days.	x		x			x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
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
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
062 05 03 03	**Navigation computer input/output**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
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**						
062 05 04 01	**Navigation and flight management**						
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
LO	Explain that a flight management system has the ability to monitor and direct both navigation and performance of the flight.	x		x			x
LO	Explain the two functions common to all FMS systems: — automatic navigation Lateral Navigation (LNAV); — flight path management Vertical Navigation (VNAV).	x		x			x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
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
062 05 04 02	**Flight management computer**						
LO	State that the centre of the flight management system is the FMC with its stored navigation and performance data.	x		x			x
062 05 04 03	**Navigation database**						
LO	State that the navigation database of the FMC may 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.	x		x			x
LO	State that the navigation database is updated every 28 days.	x		x			x
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
062 05 04 04	**Performance database**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that the performance database stores all the data relating to the specific aircraft/engine configuration, and is updated by ground staff when necessary.	x		x			x
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
062 05 04 05	**Typical input/output data from the FMC**						
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 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.	x		x			x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
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
062 05 04 06	**Determination of the FMS position of the aircraft**						
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
LO	State that the information from the sensors used may be blended into a single position by using the Kalman-filter method.	x		x			x
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**						
062 05 05 01	**Control and Display Unit (CDU)**						
LO	State that the communication link between the flight crew and the FMC is the CDU.	x		x			x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
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 navigate to pages through the data presented; — warning lights, message light and offset light.	x		x			x
062 05 05 02	**EFIS instruments (attitude display, navigation display)**						
LO	State that FMS-equipped aircraft typically has two displays on the instrument panel in front of each pilot.	x		x			x
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
062 05 05 03	**Typical modes of the navigation display**						
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; — plan mode.	x		x			x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*			*Helicopter*		*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
062 05 05 04	**Typical information on the navigation display**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
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. 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.	x		x			x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	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.						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	A wind arrow indicating wind direction according to the compass rose, and velocity in numbers next to the arrow.	x		x			x
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; — 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.	x		x			x
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; — distance to the DME station; — selected heading for the autopilot heading select bug; — state whether the display is in VOR or ILS rose mode.	x		x			x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
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 the FMS route.	x		x			x
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
062 06 00 00	**GLOBAL NAVIGATION SATELLITE SYSTEMS**						
062 06 01 00	**GPS, GLONASS, GALILEO**						
062 06 01 01	**Principles**						
LO	State that there are two main Global Navigation Satellite Systems (GNSS) 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 Global Positioning System (NAVSTAR GPS); — Russian GLObal NAvigation Satellite System (GLONASS); — European GALILEO.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that all three 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
062 06 01 02	**Operation**						
	NAVSTAR GPS						
LO	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
LO	SPS was originally designed to provide civilian users with a less accurate positioning capability than PPS.	x	x	x	x	x	x
LO	Name the three segments as follows: — space segment; — control segment; — user segment.	x	x	x	x	x	x
	Space segment						
LO	State that the space segment consists of a notional constellation of 24 operational satellites.	x	x	x	x	x	x
LO	State that the satellites are orbiting the Earth in orbits inclined 55° to the plane of the equator.	x	x	x	x	x	x
LO	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
LO	State that the satellites are distributed in 6 orbital planes with at least 4 satellites in each.	x	x	x	x	x	x
LO	State that a satellite completes an orbit in approximately 12 hours.	x	x	x	x	x	x
LO	State that each satellite broadcasts ranging signals on two UHF frequencies: L1 1575.42 MHz and L2 1227.6 MHz.	x	x	x	x	x	x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that SPS is a positioning and timing service provided on frequency L1.	x	x	x	x	x	x
LO	State that PPS uses both frequencies L1 and L2.	x	x	x	x	x	x
LO	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
LO	State that the ranging signal contains a Coarse Acquisition (C/A) code and a navigational data message.	x	x	x	x	x	x
LO	State that the navigation message contains: — almanac data; — ephemeris; — satellite clock correction parameters; — UTC parameters; — ionospheric model; — satellite health data.	x	x	x	x	x	x
LO	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
LO	State that the almanac contains the orbital data about all the satellites in the GPS constellation.	x	x	x	x	x	x
LO	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
LO	State that the clock correction parameters are data for the correction of the satellite time.	x	x	x	x	x	x
LO	State that UTC parameters are factors determining the difference between GPS time and UTC.	x	x	x	x	x	x
LO	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

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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
LO	State that GPS uses the WGS-84 model.	x	x	x	x	x	x
LO	State that two codes are transmitted on the L1 frequency, namely a C/A code and a Precision (P) code. The P code is not used for SPS.	x	x	x	x	x	x
LO	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
LO	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
LO	State that satellites are equipped with atomic clocks, which allow the system to keep very accurate time reference.	x	x	x	x	x	x
	Control segment						
LO	State that the control segment comprises: — a master control station; — ground antenna; — monitoring stations.	x	x	x	x	x	x
LO	State that the master control station is responsible for all aspects of the constellation command and control.	x	x	x	x	x	x
LO	State that the main tasks of the control segment are: — managing SPS performance; — navigation data upload; — monitoring satellites.	x	x	x	x	x	x
	User segment						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that GPS supplies three-dimensional position fixes and speed data, plus a precise time reference.	x	x	x	x	x	x
LO	State that the GPS receiver used in aviation is a multichannel type.	x	x	x	x	x	x
LO	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
LO	State that the initial distance calculated to the satellites is called pseudo-range because the difference between the GPS receiver and the satellite time references initially creates an erroneous range.	x	x	x	x	x	x
LO	State that each range defines a sphere with its centre at the satellite.	x	x	x	x	x	x
LO	State that three satellites are needed to determine a two-dimensional position.	x	x	x	x	x	x
LO	State that four spheres are needed to calculate a three-dimensional position, hence four satellites are required.	x	x	x	x	x	x
LO	State that the GPS receiver is able to synchronise to the correct time base when receiving four satellites.	x	x	x	x	x	x
LO	State that the receiver is able to calculate aircraft ground speed using the SV Doppler frequency shift and/or the change in receiver position over time.	x	x	x	x	x	x
	NAVSTAR GPS integrity						
LO	Define 'Receiver Autonomous Integrity Monitoring (RAIM)'. A technique whereby a receiver processor determines the integrity of the navigation signals.	x	x	x	x	x	x
LO	State that RAIM is achieved by consistency check among pseudo-range measurements.	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that basic RAIM requires five satellites. A sixth is for isolating a faulty satellite from the navigation solution.	x	x	x	x	x	x
LO	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
	GLONASS						
LO	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
LO	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
LO	State that the control segment provides: — monitoring of the constellation status; — correction to orbital parameters; — navigation data uploading.	x	x	x	x	x	x
LO	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
LO	State that the time reference is UTC.	x	x	x	x	x	x
LO	State that the datum used is PZ-90 Earth-centred Earth-fixed.	x	x	x	x	x	
LO	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

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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
LO	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 relates to all other satellites within the constellation.	x	x	x	x	x	x
LO	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
LO	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
LO	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

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that integrity monitoring is implemented in two ways: — Continuous automatic operability monitoring of 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.	x	x	x	x	x	x
LO	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
	GALILEO						
LO	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 altitude of 23 222 km inclined at 56° to the plane of the equator.	x	x	x	x	x	x
LO	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	State that each orbit will take 14 hours.	x	x	x	x	x	x
LO	State that each satellite has three sections: timing, signal generation and transmit.	x	x	x	x	x	x
LO	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

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State that the signal generation contains the navigation signals.	x	x	x	x	x	x
LO	State that the navigation signals consist of a ranging-code identifier and the navigation message.	x	x	x	x	x	x
LO	State that the navigation message basically contains information concerning the satellite orbit (ephemeris) and the clock references.	x	x	x	x	x	x
LO	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 transmit section.	x	x	x	x	x	x
LO	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	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	State that tracking, telemetry and command operations are controlled by sophisticated data encryption and authentication procedures.	x	x	x	x	x	x
LO	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**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	List the most significant factors affecting accuracy: — ionospheric propagation delay; — dilution of position; — satellite clock error; — satellite orbital variations; — multipath.	x	x	x	x	x	x
LO	State that Ionospheric Propagation Delay (IPD) can almost be eliminated by using two frequencies.	x	x	x	x	x	x
LO	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
LO	State that ionospheric delay is the most significant error.	x	x	x	x	x	x
LO	State that dilution of position arises from the geometry and number of satellites in view. It is called Position Dilution of Precision (PDOP).	x	x	x	x	x	x
LO	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
LO	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**						
062 06 02 01	***Ground-Based Augmentation Systems (GBAS)***						
LO	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

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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
LO	State that for a GBAS station the coverage is about 30 km.	x	x	x	x	x	x
LO	Explain 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 Ground Regional Augmentation System (GRAS).	x	x	x	x	x	x
LO	Explain that GBAS ground subsystems provide two services: precision approach service and GBAS positioning service. The precision approach service provides deviation guidance for final-approach Segments, while the GBAS positioning service provides horizontal position information to support RNAV operations in terminal areas.	x	x	x	x	x	x
LO	Explain that one ground station can support all the aircraft subsystems within its coverage providing the aircraft with approach data, corrections and integrity information for GNSS satellites in view via a VHF Data Broadcast (VDB).	x	x	x	x	x	x
LO	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.	x	x	x	x	x	x
LO	State that GBAS based on GPS is sometimes called Local Area Augmentation System (LAAS).	x	x	x	x	x	x

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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
062 06 02 02	***Satellite-Based Augmentation Systems (SBAS)***						
LO	Explain the principle of a 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
LO	State that the frequency band of the data link is identical to that of the GPS signals.	X	x	x	x	x	x
LO	Explain that the use of geostationary satellites enables messages to be broadcast over very wide areas.	X	x	x	x	x	x
LO	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
LO	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

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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 corrections for tropospheric delay.	X	x	x	x	x	x
LO	Explain that SBAS can provide approach and landing operations with vertical guidance (APV) and precision approach service.	X	x	x	x	x	x
LO	Explain the difference between 'coverage area' and 'service area'.	X	x	x	x	x	x
LO	State that Satellite-Based Augmentation Systems include: — EGNOS in western Europe and the Mediterranean; — WAAS in the USA; — MSAS in Japan; — GAGAN in India.	X	x	x	x	x	x
LO	Explain that SBAS systems regionally augment GPS and GLONASS by making them suitable for safety-critical applications such as landing aircraft.	X	x	x	x	x	x
062 06 02 03	***European Geostationary Navigation Overlay Service (EGNOS)***						
LO	State that EGNOS consists of three geostationary Inmarsat satellites which broadcast GPS lookalike signals.	X	x	x	x	x	x
LO	State that EGNOS is designed to improve accuracy to 1–2 m horizontally and 3–5 m vertically.	X	x	x	x	x	x
LO	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
062 06 02 04	***Airborne-Based Augmentation Systems (ABAS)***						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	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
LO	State that the type of ABAS using only GNSS information is named Receiver Autonomous Integrity Monitoring (RAIM).	x	x	x	x	x	x
LO	State that a system using information from additional onboard sensors is named Aircraft Autonomous Integrity Monitoring (AAIM).	x	x	x	x	x	x
LO	Explain that the typical sensors used are barometric altimeter, clock and inertial navigation system.	x	x	x	x	x	x
LO	Explain that unlike GBAS and SBAS, ABAS does not improve positioning accuracy.	x	x	x	x	x	x

L. SUBJECT 070 — OPERATIONAL PROCEDURES

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
070 00 00 00	**OPERATIONAL PROCEDURES**						
071 01 00 00	**GENERAL REQUIREMENTS**						
071 01 01 00	**ICAO Annex 6**						
071 01 01 01	**Definitions**						
LO	Alternate aerodrome: take-off alternate, en route alternate, ETOPS en route alternate, destination alternate (ICAO Annex 6, Part I, Chapter 1).	x	x				
LO	Alternate heliport (ICAO Annex 6, Part III, Section 1, Chapter 1).			x	x	x	
LO	Flight time — aeroplanes (ICAO Annex 6, Part I, Chapter 1).	x	x				
LO	Flight time — helicopters (ICAO Annex 6, Part III, Section 1, Chapter 1).			x	x	x	
071 01 01 02	**Applicability**						
LO	State that Part I shall be applicable to the operation of aeroplanes by operators authorised to conduct international commercial air transport operations (ICAO Annex 6, Part I, Chapter 2).	x	x				
LO	State that Part III shall be applicable to all helicopters engaged in international commercial air transport operations or in international general aviation operations, except it is not applicable to helicopters engaged in aerial work (ICAO Annex 6, Part III, Section 1, Chapter 2).			x	x	x	
071 01 01 03	**General**						
LO	State compliance with laws, regulations and procedures (ICAO Annex 6, Part I, Chapter 3.1/Part III, Section 2, Chapter 1.1).	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State accident prevention and flight safety programme (ICAO Annex 6, Part I, Chapter 3.2).	x	x				
LO	State flight safety documents system (ICAO Annex 6, Part I, Chapter 3.3).	x	x				
LO	State maintenance release (ICAO Annex 6, Part I, Chapter 8.8/Part III, Section 2, Chapter 6.7).	x	x	x	x	x	
LO	List and describe the lights to be displayed by aircraft (ICAO Annex 6, Part I, Appendix 1).	x	x				
071 01 02 00	**Operational requirements**						
071 01 02 01	**Applicability**						
LO	State the operational regulations applicable to commercial air transportation.	x	x	x	x	x	
LO	Nature of operations and exceptions.	x	x	x	x	x	
071 01 02 02	**General**						
LO	State that a commercial air transportation flight must meet the applicable operational requirements.	x	x	x	x	x	
LO	Flight Manual limitations — Flight through the Height Velocity (HV) envelope.			x	x	x	
LO	Define ‘Helicopter Emergency Medical Service’.			x	x	x	
LO	Operations over a hostile environment — Applicability.			x	x	x	
LO	Local area operations — Approval.			x	x	x	
LO	State the requirements about language used for crew communication and operations manual.	x	x	x	x	x	
LO	Explain the relation between MMEL and MEL.	x	x	x	x	x	

Syllabus reference	**Syllabus details and associated Learning Objectives**	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State the operator's requirements regarding a management system.	x	x	x	x	x	
LO	State the operator's requirements regarding accident prevention and flight safety programme.	x	x	x	x	x	
LO	State the operator's responsibility regarding the distinction between cabin crew members and additional crew members.	x	x				
LO	State the operations limitations regarding ditching requirements.	x	x				
LO	State the regulations concerning the carriage of persons on an aircraft.	x	x	x	x	x	
LO	State the crew members' responsibilities in the execution of their duties, and define the commander's authority.	x	x	x	x	x	
LO	State the operator's and commander's responsibilities regarding admission to the flight deck and carriage of unauthorised persons or cargo.	x	x	x	x	x	
LO	State the operator's responsibility concerning portable electronic devices.	x	x	x	x	x	
LO	State the operator's responsibilities regarding admission in an aircraft of a person under the influence of drug or alcohol.	x	x	x	x	x	
LO	State the regulations concerning endangering safety.	x	x	x	x	x	
LO	List the documents to be carried on each flight.	x	x	x	x	x	
LO	State the operator's responsibility regarding manuals to be carried.	x	x	x	x	x	
LO	List the additional information and forms to be carried on board.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	List the items of information to be retained on the ground by the operator.	x	x	x	x	x	
LO	State the operator’s responsibility regarding inspections.	x	x	x	x	x	
LO	State the responsibility of the operator and of the commander regarding the production of and access to records and documents.	x	x	x	x	x	
LO	State the operator’s responsibility regarding the preservation of documentation and recordings, including recorders recordings.	x	x	x	x	x	
LO	Define the terms used in leasing and state the responsibility and requirements of each party in various cases.	x	x	x	x	x	
071 01 02 03	**Operator certification and supervision**						
LO	State the requirement to be satisfied for the issue of an Air Operator’s Certificate (AOC).	x	x	x	x	x	
LO	State the rules applicable to air operator certification.	x	x	x	x	x	
LO	State the conditions to be met for the issue or revalidation of an AOC.	x	x	x	x	x	
LO	Explain the contents and conditions of the AOC.	x	x	x	x	x	
071 01 02 04	**Operational procedures (except long-range flight preparation)**						
LO	Define the terms used for operational procedures.	x	x				
LO	State the operator’s responsibilities regarding Operations Manual.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State the operator's responsibilities regarding competence of operations personnel.	x	x	x	x	x	
LO	State the operator's responsibilities regarding establishment of procedures.	x	x	x	x	x	
LO	State the operator's responsibilities regarding use of air traffic services.	x	x	x	x	x	
LO	State the operator's responsibilities regarding authorisation of aerodromes/ heliports by the operator.	x	x	x	x	x	
LO	Explain which elements must be considered by the operator when specifying aerodrome/heliport operating minima.	x	x	x	x	x	
LO	State the operator's responsibilities regarding departure and approach procedures.	x	x	x	x	x	
LO	State the parameters to be considered in noise-abatement procedures.	x	x				
LO	State the elements to be considered regarding routes and areas of operation.	x	x	x	x	x	
LO	State the additional specific navigation-performance requirements.	x	x	x	x	x	
LO	State the maximum distance from an adequate aerodrome for two-engine aeroplanes without an ETOPS approval.	x	x				
LO	State the requirement for alternate-airport accessibility check for ETOPS operations.	x	x				
LO	List the factors to be considered when establishing minimum flight altitude.	x	x	x	x	x	
LO	Describe the components of the fuel policy.	x	x	x	x	x	
LO	State the requirements for carrying persons with reduced mobility.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State the operator's responsibilities for the carriage of inadmissible passengers, deportees or persons in custody.	x	x	x	x	x	
LO	State the requirements for the stowage of baggage and cargo in the passenger cabin.	x	x	x	x	x	
LO	State the requirements regarding passenger seating and emergency evacuation.	x	x	x	x	x	
LO	Detail the procedures for a passenger briefing in respect of emergency equipment and exits.	x	x	x	x	x	
LO	State the flight preparation forms to be completed before flight.	x	x	x	x	x	
LO	State the commander's responsibilities during flight preparation.	x	x	x	x	x	
LO	State the rules for aerodromes/heliports selection (including ETOPS configuration).	x	x	x	x	x	
LO	Explain the planning minima for IFR flights.	x		x			
LO	State the rules for refuelling/defuelling.	x	x	x	x	x	
LO	State 'crew members at station' policy.	x	x	x	x	x	
LO	State the use of seats, safety belts and harnesses.	x	x	x	x	x	
LO	State securing of passenger cabin and galley requirements.	x	x	x	x	x	
LO	State the commander's responsibility regarding smoking on board.	x	x	x	x	x	
LO	State under which conditions a commander can commence or continue a flight regarding meteorological conditions.	x	x	x	x	x	
LO	State the commander's responsibility regarding ice and other contaminants.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State the commander's responsibility regarding fuel to be carried and in-flight fuel management.	x	x	x	x	x	
LO	State the requirements regarding the use of supplemental oxygen.	x	x	x	x	x	
LO	State the ground-proximity detection reactions.	x	x	x	x	x	
LO	Explain the requirements for use of ACAS.	x	x	x	x	x	
LO	State the commander's responsibility regarding approach and landing.	x	x	x	x	x	
LO	State the circumstances under which a report shall be submitted.	x	x	x	x	x	
071 01 02 05	**All-weather operations**						
LO	State the operator's responsibility regarding aerodrome/heliport operating minima.	x		x			
LO	List the parameters to be considered in establishing the aerodrome operating minima.	x		x			
LO	Define the criteria to be taken into consideration for the classification of aeroplanes.	x					
LO	Define the following terms: 'circling', 'low-visibility procedures', 'low-visibility take-off', 'visual approach'.	x		x			
LO	Define the following terms: 'flight control system', 'fail-passive flight control system', 'fail-operational flight control system', 'fail-operational hybrid landing system'.	x					
LO	Define the following terms: 'final approach and take-off area'.			x			
LO	State the general operating rules for low-visibility operations.	x		x			

Syllabus reference	**Syllabus details and associated Learning Objectives**	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Low-visibility operations — aerodrome/heliport considerations.	x		x			
LO	State the training and qualification requirements for flight crew to conduct low-visibility operations.	x		x			
LO	State the operating procedures for low-visibility operations.	x		x			
LO	State the operator's and commander's responsibilities regarding minimum equipment for low-visibility operations.	x		x			
LO	VFR operating minima.	x		x			
LO	Aerodrome operating minima: state under which conditions the commander can commence take-off.	x		x			
LO	Aerodrome operating minima: state that take-off minima are expressed as visibility or RVR.	x		x			
LO	Aerodrome operating minima: state the take-off RVR value depending on the facilities.	x		x			
LO	Aerodrome operating minima: state the system minima for non-precision approach.	x		x			
LO	Aerodrome operating minima: state under which conditions a pilot can continue the approach below MDA/H or DA/H.	x		x			
LO	Aerodrome operating minima: state the lowest minima for precision approach category 1 (including single-pilot operations).	x		x			
LO	Aerodrome operating minima: state the lowest minima for precision approach category 2 operations.	x		x			

Syllabus reference	**Syllabus details and associated Learning Objectives**	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Aerodrome operating minima: state the lowest minima for precision approach category 3 operations.	x					
LO	Aerodrome operating minima: state the lowest minima for circling and visual approach.	x		x			
LO	Aerodrome operating minima: state the RVR value and cloud ceiling depending on the facilities (class 1, 2 and 3).			x			
LO	Aerodrome operating minima: state under which conditions an airborne radar approach can be performed and state the relevant minima.			x			
071 01 02 06	**Instruments and equipment**						
LO	State which items do not require an equipment approval.	x	x	x	x	x	
LO	State the requirements regarding spare-fuses availability.	x	x				
LO	State the requirements regarding operating lights.	x	x	x	x	x	
LO	State the requirements regarding windshield wipers.	x	x				
LO	List the equipment for operations requiring a radio communication.			x	x	x	
LO	List the equipment for operations requiring a radio-navigation system.			x	x	x	
LO	List the minimum equipment required for day and night VFR flights.	x	x	x	x	x	
LO	List the minimum equipment required for IFR flights.	x		x			
LO	State the required equipment for single-pilot operation under IFR.	x		x			
LO	State the requirements for an altitude alert system.	x	x				

Syllabus reference	**Syllabus details and associated Learning Objectives**	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State the requirements for radio altimeters.			x	x	x	
LO	State the requirements for GPWS/TAWS.	x	x				
LO	State the requirements for ACAS.	x	x				
LO	State the conditions under which an aircraft must be fitted with a weather radar.	x	x	x	x	x	
LO	State the requirements for operations in icing conditions.	x	x	x	x	x	
LO	State the conditions under which a crew member interphone system and public address system are mandatory.	x	x	x	x	x	
LO	State the circumstances under which a cockpit voice recorder is compulsory.	x	x	x	x	x	
LO	State the rules regarding the location, construction, installation and operation of cockpit voice recorders.	x	x	x	x	x	
LO	State the circumstances under which a flight data recorder is compulsory.	x	x	x	x	x	
LO	State the rules regarding the location, construction, installation and operation of flight data recorders.	x	x	x	x	x	
LO	State the requirements about seats, seat safety belts, harnesses and child-restraint devices.	x	x	x	x	x	
LO	State the requirements about ‘Fasten seat belt’ and ‘No smoking’ signs.	x	x	x	x	x	
LO	State the requirements regarding internal doors and curtains.	x	x				
LO	State the requirements regarding first-aid kits.	x	x	x	x	x	
LO	State the requirements regarding emergency medical kits and first-aid oxygen.	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Detail the rules regarding the carriage and use of supplemental oxygen for passengers and crew.	x	x	x	x	x	
LO	Detail the rules regarding crew-protective breathing equipment.	x	x				
LO	Describe the minimum number, type and location of handheld fire extinguishers.	x	x	x	x	x	
LO	Describe the minimum number and location of crash axes and crowbars.	x	x				
LO	Specify the colours and markings used to indicate break-in points.	x	x	x	x	x	
LO	State the requirements for means of emergency evacuation.	x	x				
LO	State the requirements for megaphones.	x	x	x	x	x	
LO	State the requirements for emergency lighting.	x	x	x	x	x	
LO	State the requirements for an emergency locator transmitter.	x	x	x	x	x	
LO	State the requirements for life jackets, life rafts, survival kits and ELTs.	x	x	x	x	x	
LO	State the requirements for crew survival suit.			x	x	x	
LO	State the requirements for survival equipment.	x	x	x	x	x	
LO	State the additional requirements for helicopters operating to or from helidecks located in a hostile sea area.			x	x	x	
LO	State the requirements for an emergency flotation equipment.			x	x	x	
071 01 02 07	**Communication and navigation equipment**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain the general requirements for communication and navigation equipment.	x	x	x	x	x	
LO	State that the radio-communication equipment must provide communications on 121.5 MHz.	x	x	x	x	x	
LO	State the requirements regarding the provision of an audio selector panel.	x	x	x	x	x	
LO	List the requirements for radio equipment when flying under VFR by reference to visual landmarks.	x	x	x	x	x	
LO	List the requirements for communications and navigation equipment when operating under IFR or under VFR over routes not navigated by reference to visual landmarks.	x	x	x	x	x	
LO	State the equipment required to operate within RVSM airspace.	x	x				
071 01 02 09	**Flight crew**						
LO	State the requirement regarding crew composition and in-flight relief.	x	x	x	x	x	
LO	State the requirement for conversion training and checking.	x	x	x	x	x	
LO	State the requirement for differences training and familiarisation training.	x	x	x	x	x	
LO	State the conditions for upgrade from co-pilot to commander.	x	x	x	x	x	
LO	State the minimum qualification requirements to operate as a commander.	x	x	x	x	x	
LO	State the requirement for recurrent training and checking.	x	x	x	x	x	
LO	State the requirement for a pilot to operate on either pilot's seat.	x	x	x	x	x	
LO	State the minimum recent experience for the commander and the co-pilot.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Specify the route and aerodrome/ heliport qualification required for a commander or a pilot flying.	x	x	x	x	x	
LO	State the requirement to operate on more than one type or variant.	x	x	x	x	x	
LO	State that when a flight crew member operates both helicopters and aeroplanes, the operations are limited to one type of each.	x	x				
LO	State the training records requirement.	x	x	x	x	x	
071 01 02 10	**Cabin crew/crew members other than flight crew**						
LO	State who is regarded as a cabin crew member.	x	x	x	x	x	
LO	Detail the requirements regarding cabin crew members.	x	x	x	x	x	
LO	State the acceptability criteria.	x	x	x	x	x	
LO	State the requirements regarding senior cabin crew members.	x	x	x	x	x	
LO	State the conditions to operate on more than one type or variant.	x	x	x	x	x	
071 01 02 11	**Manuals, logs and records**						
LO	Explain the general rules for the operations manual.	x	x	x	x	x	
LO	Explain the structure and subject headings of the operations manual.	x	x	x	x	x	
LO	State the requirements for a journey logbook.	x	x	x	x	x	
LO	Describe the requirements regarding the operational flight plan.	x	x	x	x	x	
LO	State the requirements for document-storage periods.	x	x	x	x	x	
071 01 02 12	**Flight and duty-time limitations and rest requirements**						
LO	Explain the definitions used for flight-time regulation.	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	State the flight and duty limitations.	x	x				
LO	State the requirements regarding the maximum daily flight-duty period.	x	x				
LO	State the requirements regarding rest periods.	x	x				
LO	Explain the possible extension of flight-duty period due to in-flight rest.	x	x				
LO	Explain the captain's discretion in case of unforeseen circumstances in actual flight operations.	x	x				
LO	Explain the regulation regarding standby.	x	X				
LO	State the requirements regarding flight-duty, duty and rest-period records.	x	x				
071 01 02 13	**Transport of dangerous goods by air**						
LO	Explain the terminology relevant to dangerous goods.	x	x	x	x	X	
LO	Explain the scope of the regulation.	x	x	x	x	x	
LO	Explain the limitations on the transport of dangerous goods.	x	x	x	x	x	
LO	State the requirements for the acceptance of dangerous goods.	x	x	x	x	x	
LO	State the requirements regarding inspection for damage, leakage or contamination.	x	x	x	x	x	
LO	Explain the loading restrictions.	x	x	x	x	x	
LO	State the requirement for provision of information to the crew.	x	x	x	x	x	
LO	Explain the requirements for dangerous goods incident and accident reports.	x	x	x	x	x	
071 01 03 00	**Long-range flights**						
071 01 03 01	**Flight management**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Navigation-planning procedures: — describe the operator's responsibilities concerning ETOPS routes; — list the factors to be considered by the commander before commencing the flight.	x					
LO	Selection of a route: — describe the meaning of the term 'adequate aerodrome'; — describe the limitations on extended-range operations with two-engine aeroplanes with and without ETOPS approval.	x					
LO	Selection of cruising altitude (MNPSA Manual Chapter 4): — specify the appropriate cruising levels for normal long-range IFR flights and for those operating on the North Atlantic Operational Track Structure.	x					
LO	Selection of alternate aerodrome: — state the circumstances in which a take-off alternate must be selected; — state the maximum flight distance of a take-off alternate for: two-engine aeroplane, ETOPS-approved aeroplane, three or four-engine aeroplane; — state the factors to be considered in the selection of a take-off alternate; — state when a destination alternate need not be selected; — state when two destination alternates must be selected; — state the factors to be considered in the selection of a destination alternate aerodrome; — state the factors to be considered in the selection of an en route alternate aerodrome.	x					

Syllabus reference	**Syllabus details and associated Learning Objectives**	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Minimum time routes: — define, construct and interpret minimum time route (route giving the shortest flight time from departure to destination adhering to all ATC and airspace restrictions).	x					

071 01 03 02	**Transoceanic and polar flight**						
LO	(ICAO Doc 7030) — Describe the possible indications of navigation-system degradation. — Describe by what emergency means course and INS can be cross-checked in the case of: three navigation systems, two navigation systems. — Interpret VOR, NDB, VOR/DME information to calculate aircraft position and aircraft course. — Describe the general ICAO procedures applicable in North Atlantic airspace (NAT) if the aircraft is unable to continue the flight in accordance with its air traffic control clearance. — Describe the ICAO procedures applicable in North Atlantic Airspace (NAT) in case of radio-communication failure. — Describe the recommended initial action if an aircraft is unable to obtain a revised air traffic control clearance. — Describe the subsequent action for: aircraft able to maintain assigned flight level, and aircraft unable to maintain assigned flight level. — Describe determination of tracks and courses for random routes in NAT. — Specify the method by which planned tracks are defined (by latitude and longitude) in the NAT region: when operating predominately in an east–west direction south of 70°N, when operating predominately in an east–west direction north of 70°N. — State the maximum flight time recommended between significant points. — Specify the method by which planned tracks are defined for flights operating predominantly in a north–south direction. — Describe how the desired route must be specified in the air traffic control flight plan.	x					

LO	Polar navigation *Terrestrial magnetism characteristics in polar zones* — Explain why magnetic compasses become unreliable or useless in polar zones. — State in which area VORs are referenced to the true north. *Specific problems of polar navigation* — Describe the general problems of polar navigation. — Describe what precautions can be taken when operating in the area of compass unreliability as a contingency against INS failure. — Describe how grid navigation can be used in conjunction with a Directional Gyro (DG) in polar areas. — Use polar stereographic chart and grid coordinates to solve polar navigation problems. — Use polar stereographic chart and grid coordinates to calculate navigation data. — Use INS information to solve polar navigation problems. — Define, calculate: transport precession, Earth-rate (astronomic) precession, convergence factor. — Describe the effect of using a free gyro to follow a given course. — Describe the effect of using a gyro compass with hourly rate corrector unit to follow a given course. — Convert grid navigation data into true navigation data, into magnetic navigation data, and into compass navigation data. — Justify the selection of a different 'north' reference at a given position. — Calculate the effects of gyro drift due to the Earth's rotation (15 degrees / h × sin Lm).	x					
071 01 03 03	**MNPS airspace**						
LO	Geographical limits: — state the lateral dimensions (in general terms) and vertical limits of MNPS airspace (ICAO Doc 7030 NAT/RAC-2 3.2.1);	x					

	— state that operators must ensure that crew follow NAT MNPSA Operations Manual procedures (ICAO Doc 7030 NAT/RAC-2 3.2.3).						
LO	Define the following acronyms: MNPS, MNPSA, OCA, OTS, PRM, PTS, RVSM, LRNS, MASPS, SLOP, WATRS (MNPSA Manual, Glossary of Terms).	x					
LO	Aircraft system requirements (MNPSA Manual, Chapter 1): — navigation requirements for unrestricted MNPS airspace operations; — routes for use by aircraft not equipped with two LRNSs: routes for aircraft with only one LRNS, routes for aircraft with short-range navigation equipment only; — performance monitoring.	x					
LO	Organised Track System (MNPSA Manual, Chapter 2): — construction of the Organised Track System (OTS); — NAT track message; — OTS changeover periods.	x					
LO	Other routes and route structures within or adjacent to NAT MNPS airspace (MNPSA Manual, Chapter 3): — other routes within NAT MNPS airspace; — route structures adjacent to NAT MNPS airspace: North American routes (NARs), Canadian domestic track systems, routes between North America and the Caribbean area.	x					
LO	Flight planning (MNPSA Manual, Chapter 4): — all flights should plan to operate on great-circle tracks joining successive significant waypoints; — during the hours of validity of the OTS, operators are encouraged to flight plan as follows: in accordance with the OTS or along a route to join or leave an outer track of the OTS or on a random route to remain clear of the OTS; — flight levels available on OTS tracks during OTS periods; — flight levels on random tracks or outside OTS periods (appropriate direction levels).	x					

	LO	Oceanic ATC Clearances (MNPSA Manual, Chapter 5): — it is recommended that pilots should request their Oceanic Clearance at least 40 minutes prior to the oceanic entry point ETA; — pilots should notify the Oceanic Area control Centre (OAC) of the maximum acceptable flight level possible at the boundary; — at some airports, which are situated close to oceanic boundaries, the Oceanic Clearance must be obtained before departure; — if an aircraft, which would normally be RVSM and/or MNPS approved, encounters, whilst en route to the NAT Oceanic Airspace, a critical in-flight equipment failure, or at dispatch is unable to meet the MEL requirements for RVSM or MNPS approval on the flight, then the pilot must advise ATC at initial contact when requesting Oceanic Clearance; — After obtaining and reading back the clearance, the pilot should monitor the forward estimate for oceanic entry, and if this changes by 3 minutes or more, should pass a revised estimate to ATC; — the pilot should pay particular attention when the issued clearance differs from the flight plan, as a significant proportion of navigation errors investigated in the NAT involve an aircraft which has followed its flight plan rather than its differing clearance; — if the entry point of the oceanic route on which the flight is cleared differs from that originally requested and/or the oceanic flight level differs from the current flight level, the pilot is responsible for requesting and obtaining the necessary domestic re-clearance; — there are three elements to an Oceanic Clearance: route, Mach number and flight level. These elements serve to provide for the three basic elements of separation: lateral, longitudinal and vertical.	x					

	LO	Communications and position-reporting procedures (MNPSA Manual, Chapter 6) *HF voice communications* — Pilots communicate with OACs via aeradio stations staffed by communicators who have no executive ATC authority. Messages are relayed, from the ground station to the air traffic controllers in the relevant OAC for action. — Frequencies from the lower HF bands tend to be used for communications during night-time and those from the higher bands during daytime. — When initiating contact with an aeradio station, the pilot should state the HF frequency in use. *SATCOM voice communications* Since oceanic traffic typically communicates with ATC through aeradio facilities, a SATCOM call made due to unforeseen inability to communicate by other means should be made to such a facility rather than the ATC centre, unless the urgency of the communication dictates otherwise. An air-to-air VHF frequency has been established for worldwide use when aircraft are out of range of VHF ground stations which utilise the same or adjacent frequencies. This frequency (123.45 MHz) is intended for pilot-to-pilot exchanges of operationally significant information. Standard position report message type. Some aircraft flying in the NAT are required to report MET observations of wind speed and direction plus outside-air temperature. Any turbulence encountered should be included in these reports. General guidance for aircraft operating in, or proposing to operate in, the NAT region, which experience a communications failure: general provisions, onboard HF equipment failure, poor HF propagation conditions, loss of HF communications prior to entry into the NAT, loss of HF communications after entering the NAT. All turbine-engine aeroplanes having a maximum certified take-off mass exceeding 5,700 kg or authorised to carry more than 19 passengers are required to carry and operate ACAS II in the NAT region.	x					

	LO	Application of Mach number technique (MNPSA Manual, Chapter 7): — practical experience has shown that when two or more turbojet aircraft, operating along the same route at the same flight level, maintain the same Mach number, they are more likely to maintain a constant time interval between each other than when using other methods; — pilots must ensure that any required corrections to the indicated Mach number are taken into account when complying with the true Mach number specified in the ATC clearance; — after leaving oceanic airspace, pilots must maintain their assigned Mach number in domestic controlled airspace unless and until the appropriate ATC unit authorises a change.	x					
	LO	MNPS flight operation & navigation procedures (MNPSA Manual, Chapter 8): — the pre-flight procedures for any NAT MNPS flight must include a UTC time check and resynchronisation of the aircraft master clock; — state the use of the Master Document; — state the requirements for position plotting; — PRE-FLIGHT PROCEDURES: alignment of IRS, Satellite Navigation Availability Prediction Programme for flights using GNSS LRNS, loading of initial waypoints, flight plan check; — IN-FLIGHT PROCEDURES: ATC Oceanic Clearance, entering the MNPS airspace and reaching an oceanic waypoint, routine monitoring; — Strategic Lateral Offset Procedure (SLOP): state that along a route or track there will be three positions that an aircraft may fly: centre line or one or two miles right.	x					

LO	RVSM flight in MNPS airspace (MNPSA Manual, Chapter 9): — state the altimeter cross-check to be performed before MNPS airspace entry; — state the altimeter cross-check to be performed into the MNPS airspace; — in NAT MNPS airspace, pilots always have to report to ATC immediately on reaching any new cruising level; — crews should report when a 300 ft or more deviation occurs.	x						
LO	Navigation system degradation or failure (MNPSA Manual, Chapter 10) For this part, consider aircraft equipped with only two operational LRNSs. State the requirements for the following situations: — one system fails before take-off; — one system fails before the OCA boundary is reached; — one system fails after the OCA boundary is crossed; — the remaining system fails after entering MNPS airspace.	x						
LO	Special procedures for in-flight contingencies (MNPSA Manual, Chapter 11) *General* — Until a revised clearance is obtained, the specified NAT in-flight contingency procedures should be carefully followed. — The general concept of these NAT in-flight contingency procedures is, whenever operationally feasible, to offset from the assigned route by 15 NM and climb or descend to a level which differs from those normally used by 500 ft if below FL410 or by 1 000 ft if above FL410. — State the factors which may affect the direction of turn: direction to an alternate airport, terrain clearance, levels allocated on adjacent routes or tracks and any known SLOP offsets adopted by other nearby traffic. *Deviations around severe weather* — State that if the deviation is to be greater than 10 NM, the assigned flight level must be changed by ± 300 ft depending on the followed track and the direction of the deviation (Table 1).	x						
071 01 03 04	**ETOPS**							

LO	State that ETOPS approval is part of an AOC.	x					
LO	State that prior to conducting an ETOPS flight, an operator shall ensure that a suitable ETOPS en route alternate is available, within either the approved diversion time or a diversion time based on the MEL-generated serviceability status of the aeroplane, whichever is shorter.	x					
LO	State the requirements for take-off alternate.	x					
LO	State the planning minima for ETOPS en route alternate.	x					
071 02 00 00	**SPECIAL OPERATIONAL PROCEDURES AND HAZARDS (GENERAL ASPECTS)**						
071 02 01 00	**Operations Manual**						
071 02 01 01	**Operating procedures**						
LO	State that all non-type-related operational policies, instructions and procedures needed for a safe operation are included in Part A of the Operations Manual.	x	x	x	x	x	
LO	State that the following items are included into Part A: de-icing and anti-icing on the ground, adverse and potentially hazardous atmospheric conditions, wake turbulence, incapacitation of crew members, use of the minimum equipment and configuration deviation list(s), security, handling of accidents and occurrences.	x	x	x	x	x	
LO	State that the following items are included into Part A: altitude alerting system procedures, ground proximity warning system procedures, policy and procedures for the use of TCAS/ACAS.	x	x				
LO	State that the following items are included into Part A: rotor downwash.			x	x	x	
LO	Define the following terms: 'commencement of flight', 'inoperative', 'MEL', 'MMEL', rectification interval.	x	x	x	x	x	
LO	Define the 'limits of MEL applicability'.	x	x	x	x	x	
LO	Identify the responsibilities of the operator and the authority with regard to MEL and MMEL.	x	x	x	x	x	
LO	State the responsibilities of the crew members with regard to MEL.	x	x	x	x	x	
LO	State the responsibilities of the commander with regard to MEL.	x	x	x	x	x	

071 02 01 02	**Aeroplane/helicopter operating matters — type-related**						
LO	State that all type-related instructions and procedures needed for a safe operation are included in Part B of the Operations Manual. They will take account of any differences between types, variants or individual aircraft used by the operator.	x	x	x	x	x	
LO	State that the following items are included into Part B: abnormal and emergency procedures, configuration deviation list, minimum equipment list, emergency evacuation procedures.	x	x				
LO	State that the following items are included into Part B: emergency procedures, configuration deviation list, minimum equipment list, emergency evacuation procedures.			x	x	x	
071 02 02 00	**Icing conditions**						
071 02 02 01	**On ground de-icing/anti-icing procedures, types of de-icing/anti-icing fluids**						
LO	Define the following terms: 'anti-icing', 'de-icing', 'one-step de-icing/anti-icing', 'two-step de-icing/anti-icing', 'holdover time'. (ICAO Doc 9640 Glossary)	x	x				
LO	Define the following weather conditions: 'drizzle', 'fog', 'freezing fog', 'freezing drizzle', 'freezing rain', 'frost', 'rain', 'rime', 'slush', 'snow', 'dry snow', 'wet snow'. (ICAO Doc 9640 Glossary)	x	x	x	x	x	
LO	Describe 'The clean aircraft concept' as presented in the relevant chapter of ICAO Doc 9640. (ICAO Doc 9640, Chapter 2)	x	x				
LO	List the types of de-icing/anti-icing fluids available. (ICAO Doc 9640, Chapter 4)	x	x	x	x	x	
LO	State the procedure to be followed when an aeroplane has exceeded the holdover time. (ICAO Doc 9640, Chapter 4)	x	x				
LO	Interpret the fluid holdover time tables and list the factors which can reduce the fluid protection time. (ICAO Doc 9640, Chapter 5 + Attachment tables)	x	x				

LO	State that the pre-take-off check, which is the responsibility of the pilot-in-command, ensures that the critical surfaces of the aeroplane are free of ice, snow, slush or frost just prior to take-off. This check shall be accomplished as close to the time of take-off as possible and is normally made from within the aeroplane by visually checking the wings. (ICAO Doc 9640, Chapter 6)	x	x				
LO	State that an aircraft has to be treated symmetrically. (ICAO Doc 9640, Chapter 11)	x	x				
LO	State that an operator shall establish procedures to be followed when ground de-icing and anti-icing and related inspections of the aeroplane(s) are necessary.	x	x	x	x	x	
LO	State that a commander shall not commence take-off unless the external surfaces are clear of any deposit which might adversely affect the performance and/or controllability of the aircraft except as permitted in the Flight Manual.	x	x	x	x	x	
071 02 02 02	**Procedure to apply in case of performance deterioration, on ground/in flight**						
LO	State that the effects of icing are wide-ranging, unpredictable and dependent upon individual aeroplane design. The magnitude of these effects is dependent upon many variables, but the effects can be both significant and dangerous. (ICAO Doc 9640, Chapter 1)	x	x	x	x	x	
LO	State that in icing conditions, for a given speed and a given angle of attack, wing lift can be reduced by as much as 30 % and drag increased by up to 40 %. State that these changes in lift and drag will significantly increase stall speed, reduce controllability and alter flight characteristics. (ICAO Doc 9640, Chapter 1)	x	x	x	x	x	
LO	State that ice on critical surfaces and on the airframe may also break away during take-off and be ingested into engines, possibly damaging fan and compressor blades. (ICAO Doc 9640, Chapter 1)	x	x	x	x	x	
LO	State that ice forming on pitot tubes and static ports or on angle-of-attack vanes may give false altitude, airspeed, angle-of-attack and engine-power information for air-data systems. (ICAO Doc 9640, Chapter 1)	x	x	x	x	x	

LO	State that ice, frost and snow formed on the critical surfaces on the ground can have a totally different effect on aircraft flight characteristics than ice formed in flight. (ICAO Doc 9640, Chapter 1)	x	x	x	x	x	
LO	State that flight in known icing conditions is subject to limitations found in Part B of the Operations Manual.	x	x	x	x	x	
LO	State where procedures and performances regarding flight in expected or actual icing conditions are located.	x	x	x	x	x	
071 02 03 00	**Bird-strike risk and avoidance**						
LO	State that presence of birds constituting a potential hazard to aircraft operations is part of the pre-flight information. (ICAO Annex 15, Chapter 8)	x	x	x	x	x	
LO	State that information concerning the presence of birds observed by aircrews is made available to the Aeronautical Information Service for such distribution as the circumstances necessitate. (ICAO Annex 15, Chapter 8)	x	x	x	x	x	
LO	State that AIP ENR 5.6 contains information regarding bird migrations. (ICAO Annex 15, Appendix 1)	x	x	x	x	x	
LO	State significant data regarding bird strikes contained in ICAO Doc 9137. (ICAO Doc 9137, Part 3, 1.1.6)	x	x	x	x	x	
LO	List incompatible land use around airports. (ICAO Doc 9137, Part 3, 10.4)	x	x	x	x	x	
LO	Define the commander's responsibilities regarding the reporting of bird hazards and bird strikes.	x	x	x	x	x	
071 02 04 00	**Noise abatement**						
071 02 04 01	**Noise-abatement procedures**						
LO	Define the operator responsibilities regarding establishment of noise-abatement procedures.	x	x	x	x	x	
LO	State the main purpose of NADP 1 and NADP 2. (ICAO Doc 8168, Volume 1, Part V, 3.1.1)	x	x	x	x	x	

LO	State that the pilot-in-command has the authority to decide not to execute a noise-abatement departure procedure if conditions preclude the safe execution of the procedure. (ICAO Doc 8168, Volume 1, Part V, 3.2.1.3)	x	x	x	x	x	
071 02 04 02	**Influence of the flight procedure (departure, cruise, approach)**						
LO	List the main parameters for NADP 1 and NADP 2 (i.e. speeds, heights, etc.). (ICAO Doc 8168, Volume 1, Part V, Appendix to Chapter 3)	x	x				
LO	State that a runway lead-in lighting system should be provided where it is desired to provide visual guidance along a specific approach path for purposes of noise abatement. (ICAO Annex 14 - Volume 1, 5.3.7.1/Vol 2, 5.3.4.1)	x	x	x	x	x	
LO	State that detailed information about noise-abatement procedures is to be found in AD 2 and 3 of the AIP. (ICAO Annex 15, Appendix 1)	x	x	x	x	x	
071 02 04 03	**Influence by the pilot (power setting, low drag)**						
LO	List the adverse operating conditions under which noise-abatement procedures in the form of reduced-power take-off should not be required. (ICAO Doc 8168, Volume 1, Part V, 3.2.2)	x	x				
LO	List the adverse operating conditions under which noise-abatement procedures during approach should not be required. (ICAO Doc 8168, Volume 1, Part V, 3.4.4)	x	x				
LO	State the rule regarding the use of reverse thrust on landing. (ICAO Doc 8168, Volume 1, Part V, 3.5)	x	x				
071 02 04 04	**Influence by the pilot (power setting, track of helicopter)**						
LO	List the adverse operating conditions under which noise-abatement procedures in the form of reduced-power take-off should not be required. (ICAO Doc 8168, Volume 1, Part V, 3.2.2)			x	x	x	
071 02 05 00	**Fire and smoke**						
071 02 05 01	**Carburettor fire**						
LO	List the actions to be taken in the event of a carburettor fire.	x	x				

071 02 05 02	**Engine fire**						
LO	List the actions to be taken in the event of an engine fire.	x	x				
071 02 05 03	**Fire in the cabin, cockpit, cargo compartment**						
LO	Identify the different types of extinguishants and the type of fire on which each one may be used.	x	x				
LO	Describe the precautions to be considered in the application of fire extinguishant.	x	x				
LO	Identify the appropriate handheld extinguishers to be used in the cockpit, the passenger cabin and toilets, and in the cargo compartments.	x	x				
071 02 05 04	**Smoke in the cockpit and cabin**						
LO	List the actions to be taken in the event of smoke in the cockpit or in the cabin.	x	x				
071 02 05 05	**Actions in case of overheated brakes**						
LO	Describe the problems and safety precautions following overheated brakes after landing or a rejected take-off.	x	x				
071 02 06 00	**Decompression of pressurised cabin**						
071 02 06 01	**Slow decompression**						
LO	Indicate how to detect a slow decompression or an automatic pressurisation system failure.	x	x				
LO	Describe the actions required following a slow decompression.	x	x				
071 02 06 02	**Rapid and explosive decompression**						
LO	Indicate how to detect a rapid or an explosive decompression.	x	x				
071 02 06 03	**Dangers and action to be taken**						
LO	Describe the actions required following a rapid or explosive decompression.	x	x				
LO	Describe the effects on aircraft occupants of a slow decompression and a rapid or explosive decompression.	x	x				
071 02 07 00	**Wind shear and microburst**						
071 02 07 01	**Effects and recognition during departure and approach**						
LO	Define the meaning of the term 'low-level windshear'. (ICAO Circular 186, Chapter 1)	x	x	x	x	x	

LO	Define: vertical wind shear, horizontal wind shear, updraft and downdraft wind shear. (ICAO Circular 186, Chapter 2)	x	x	x	x	x	
LO	Identify the meteorological phenomena associated with wind shear. (ICAO Circular 186, Chapter 3)	x	x	x	x	x	
LO	Explain recognition of wind shear. (ICAO Circular 186, Chapter 4)	x	x	x	x	x	
071 02 07 02	**Actions to avoid and actions to take during encounter**						
LO	Describe the effects of and actions required when encountering wind shear, at take-off and approach. (ICAO Circular 186, Chapter 4)	x	x	x	x	x	
LO	Describe the precautions to be taken when wind shear is suspected, at take-off and approach. (ICAO Circular 186, Chapter 4)	x	x	x	x	x	
LO	Describe the effects of and actions required following entry into a strong downdraft wind shear. (ICAO Circular 186, Chapter 4)	x	x	x	x	x	
LO	Describe a microburst and its effects. (ICAO Circular 186, Chapter 4)	x	x	x	x	x	
071 02 08 00	**Wake turbulence**						
071 02 08 01	**Cause**						
LO	Define the term ‘wake turbulence’. (ICAO Doc 4444, 4.9)	x	x	x	x	x	
LO	Describe tip vortices circulation. (ICAO Doc 9426, Part II)	x	x	x	x	x	
LO	Explain when vortex generation begins and ends. (ICAO Doc 9426, Part II)	x	x	x	x	x	
LO	Describe vortex circulation on the ground with and without crosswind. (ICAO Doc 9426, Part II)	x	x	x	x	x	
071 02 08 02	**List of relevant parameters**						
LO	List the three main factors which, when combined, give the strongest vortices (heavy, clean, slow). (ICAO Doc 9426, Part II)	x	x	x	x	x	
LO	Describe the wind conditions which are worst for wake turbulence near the ground. (ICAO Doc 9426, Part II)	x	x	x	x	x	
071 02 08 03	**Actions to be taken when crossing traffic, during take-off and landing**						

LO	Describe the actions to be taken to avoid wake turbulence, specially separations. (ICAO Doc 4444, 5)	x	x	x	x	x	
071 02 09 00	**Security (unlawful events)**						
071 02 09 01	**ICAO Annex 17**						
LO	Give the following definitions: aircraft security check, screening, security, security-restricted area, unidentified baggage. (ICAO Annex 17, 1)	x	x	x	x	x	
LO	Give the objectives of security. (ICAO Annex 17, 2.1)	x	x	x	x	x	
071 02 09 02	**Use of Secondary Surveillance Radar (SSR)**						
LO	Describe the commander's responsibilities concerning notifying the appropriate ATS unit. (ICAO Annex 17 Attachment)	x	x	x	x	x	
LO	Describe the commander's responsibilities concerning operation of SSR. (ICAO Annex 17 Attachment)	x	x	x	x	x	
LO	Describe the commander's responsibilities concerning departing from assigned track and/or cruising level. (ICAO Annex 17 Attachment)	x	x	x	x	x	
LO	Describe the commander's responsibilities concerning the action required or being requested by an ATS unit to confirm SSR code and ATS interpretation response. (ICAO Annex 17 Attachment)	x	x	x	x	x	
071 02 09 03	**Security**						
LO	State the requirements regarding training programmes.	x	x	x	x	x	
LO	State the requirements regarding reporting acts of unlawful interference.	x	x	x	x	x	
LO	State the requirements regarding aircraft search procedures.	x	x	x	x	x	
071 02 10 00	**Emergency and precautionary landings**						
071 02 10 01	**Definition**						
LO	Define 'ditching', 'precautionary landing', 'emergency landing'.	x	x	x	x	x	
LO	Describe a ditching procedure.	x	x	x	x	x	

LO	Describe a precautionary landing.	x	x	x	x	x	
LO	Explain the factors to be considered when deciding to make a precautionary/emergency landing or ditching.	x	x	x	x	x	
071 02 10 02	**Cause**						
LO	List some reasons that may require a ditching, a precautionary landing or an emergency landing.	x	x	x	x	x	
071 02 10 03	**Passenger information**						
LO	Describe the passenger briefing to be given before conducting a precautionary/emergency landing or ditching (including evacuation).	x	x	x	x	x	
071 02 10 04	**Action after landing**						
LO	Describe the actions and responsibilities of crew members after landing.	x	x	x	x	x	
071 02 10 05	**Evacuation**						
LO	State that the aircraft must be stopped and the engine shut down before launching an emergency evacuation.	x	x	x	x	x	
LO	State that evacuation procedures are to be found in Part B of the Operations Manual.	x	x	x	x	x	
LO	State the CS-25 requirements regarding evacuation procedures. (CS 25.803 + Appendix J)	x	x				
071 02 11 00	**Fuel jettisoning**						
071 02 11 01	**Safety aspects**						
LO	State that an aircraft may need to jettison fuel so as to reduce its landing mass in order to effect a safe landing. (ICAO Doc 4444, 15.5.3)	x	x				
LO	State that when an aircraft operating within controlled airspace needs to jettison fuel, the flight crew shall coordinate with ATC the following: route to be flown which, if possible, should be clear of cities and towns, preferably over water and away from areas where thunderstorms have been reported or are expected; the level to be used, which should be not less than 1 800 m (6 000 ft); and the duration of fuel jettisoning. (ICAO Doc 4444, 15.5.3)	x	x				
LO	State that flaps and slats may adversely affect fuel jettisoning. (CS 25.1001)	x	x				

071 02 11 02	**Requirements**						
LO	State that a fuel-jettisoning system must be installed on each aeroplane unless it is shown that the aeroplane meets some CS-25 climb requirements. (CS 25.1001)	x	x				
LO	State that a fuel-jettisoning system must be capable of jettisoning enough fuel within 15 minutes. (CS 25.1001)	x	x				
071 02 12 00	**Transport of dangerous goods**						
071 02 12 01	**ICAO Annex 18**						
LO	Give the following definitions: dangerous goods, dangerous goods accident, dangerous goods incident, exemption, incompatible, packaging, UN number. (ICAO Annex 18, Chapter 1)	x	x	x	x	x	
LO	State that detailed provisions for dangerous goods transportation are contained in the Technical Instructions for the Safe Transport of Dangerous Goods by Air (Doc 9284). (ICAO Annex 18, Chapter 2, 2.2.1)	x	x	x	x	x	
LO	State that in case of an in-flight emergency, the pilot-in-command must inform the ATC of dangerous goods transportation. (ICAO Annex 18, Chapter 9, 9.5)	x	x	x	x	x	
071 02 12 02	**Technical Instructions (ICAO Doc 9284)**						
LO	Explain the principle of compatibility and segregation. (ICAO Doc 9284)	x	x	x	x	x	
LO	Explain the special requirements for the loading of radioactive materials. (ICAO Doc 9284)	x	x	x	x	x	
LO	Explain the use of the dangerous goods list. (ICAO Doc 9284)	x	x	x	x	x	
LO	Identify the labels. (ICAO Doc 9284)	x	x	x	x	x	
071 02 12 03	**Transport of dangerous goods by air**						
LO	State that dangerous goods transportation is subject to operator approval.	x	x	x	x	x	
LO	Identify articles and substances, which would otherwise be classed as dangerous goods, that are excluded from the provisions.	x	x	x	x	x	
LO	State that some articles and substances may be forbidden for air transportation.	x	x	x	x	x	
LO	State that packing must comply with the Technical Instructions specifications.	x	x	x	x	x	

LO	List the labelling and marking requirements.	x	x	x	x	x	
LO	List the Dangerous Goods Transport Document requirements.	x	x	x	x	x	
LO	List the Acceptance of Dangerous Goods requirements.	x	x	x	x	x	
LO	Explain the need for an inspection prior to loading on an aircraft.	x	x	x	x	x	
LO	State that some dangerous goods are designated for carriage only on cargo aircraft.	x	x	x	x	x	
LO	State that accidents or incidents involving dangerous goods are to be reported.	x	x	x	x	x	
LO	State that misdeclared or undeclared dangerous goods found in baggage are to be reported.	x	x	x	x	x	
071 02 13 00	**Contaminated runways**						
071 02 13 01	**Kinds of contamination**						
LO	Define a 'contaminated runway', a 'damp runway', a 'wet runway', and a 'dry runway'.	x	x				
LO	List the different types of contamination: damp, wet or water patches, rime or frost-covered, dry snow, wet snow, slush, ice, compacted or rolled snow, frozen ruts or ridges. (ICAO Annex 15, Appendix 2)	x	x				
LO	Give the definitions of the various types of snow. (ICAO Annex 15, Appendix 2)	x	x				
071 02 13 02	**Estimated surface friction, friction coefficient**						
LO	Identify the difference between friction coefficient and estimated surface friction. (ICAO Annex 15, Appendix 2)	x	x				
LO	State that when friction coefficient is 0.40 or higher, the expected braking action is good. (ICAO Annex 15, Appendix 2)	x	x				
071 02 13 03	**Hydroplaning principles and effects**						
LO	Define the different types of hydroplaning. (NASA TM-85652/Tire friction performance/ pp. 6 to 9)	x	x				

LO	Compute the two dynamic hydroplaning speeds using the following formulas: Spin-down speed (rotating tire) (kt) = 9 square root (pressure in PSI) Spin-up speed (non-rotating tire) (kt) = 7.7 square root (pressure in PSI). (NASA TM-85652/Tire friction performance /p. 8)	x	x				
LO	State that it is the spin-up speed rather than the spin-down speed which represents the actual tire situation for aircraft touchdown on flooded runways. (NASA TM-85652/Tire friction performance/p. 8)	x	x				
071 02 13 04	**Procedures**						
LO	State that some wind limitations may apply in case of contaminated runways. Those limitations are to be found in Part B of the Operations Manual — Limitations.	x	x				
LO	State that the procedures associated with take-off and landing on contaminated runways are to be found in Part B of the Operations Manual — Normal procedures.	x	x				
LO	State that the performances associated with contaminated runways are to be found in Part B of the Operations Manual — Performance.	x	x				
071 02 13 05	**SNOWTAM**						
LO	Interpret from a SNOWTAM the contamination and braking action on a runway.	x	x				
071 02 14 00	**Rotor downwash**						
071 02 14 01	**Describe downwash**						
LO	Describe the downwash.			x	x	x	
071 02 14 02	**Effects**						
LO	Explain the effects on: soil erosion, water dispersal and spray, recirculation, damage to property, loose articles.			x	x	x	
071 02 15 00	**Operation influence by meteorological conditions (Helicopter)**						
071 02 15 01	**White-out/sand/dust**						
LO	Give the definition of ‘white-out’.			x	x	x	
LO	Describe loss of spatial orientation.			x	x	x	
LO	Describe take-off and landing techniques.			x	x	x	

071 02 15 02	**Strong winds**						
LO	Describe blade sailing.			x	x	x	
LO	Describe wind operating envelopes.			x	x	x	
LO	Describe vertical speed problems.			x	x	x	
071 02 15 03	**Mountain environment**						
LO	Describe constraints associated with mountain environment.			x	x	x	
071 03 00 00	**EMERGENCY PROCEDURES (HELICOPTER)**						
071 03 01 00	**Influence of technical problems**						
071 03 01 01	**Engine failure**						
LO	Describe techniques for failure in: hover, climb, cruise, approach.			x	x	x	
071 03 01 02	**Fire in cabin/cockpit/engine**						
LO	Describe the basic actions when encountering fire in the cabin, cockpit or engine.			x	x	x	
071 03 01 03	**Tail/rotor/directional control failure**						
LO	Describe the basic actions following loss of tail rotor.			x	x	x	
LO	Describe the basic actions following loss of directional control.			x	x	x	
071 03 01 04	**Ground resonance**						
LO	Describe recovery actions.			x	x	x	
071 03 01 05	**Blade stall**						
LO	Describe cause and recovery actions when encountering retreating blade stall.			x	x	x	
071 03 01 06	**Settling with power (vortex ring)**						
LO	Describe prerequisite conditions and recovery actions.			x	x	x	
071 03 01 07	**Overpitch**						
LO	Describe recovery actions.			x	x	x	
071 03 01 08	**Overspeed: rotor/engine**						
LO	Describe overspeed control.			x	x	x	
071 03 01 09	**Dynamic rollover**						
LO	Describe potential conditions and recovery action.			x	x	x	
071 03 01 10	**Mast bumping**						

LO	Describe conditions 'conducive to' and 'avoidance of' effect.			x	x	x	

M. SUBJECT 081 — PRINCIPLES OF FLIGHT (AEROPLANE)

(1) The following standard conventions are used for certain mathematical symbols:

*	multiplication
≥	greater than or equal to
≤	less than or equal to
SQRT( )	square root of the function, symbol or number in round brackets

(2) Normally, it should be assumed that the effect of a variable under review is the only variation that needs to be addressed, unless specifically stated otherwise.

(3) Candidates are expected in simple calculations to be able to convert knots (kt) into metres/second (m/s), and know the appropriate conversion factors by heart.

(4) In the subsonic range, as covered under subject 081 01, compressibility effects normally are not considered, unless specifically mentioned.

(5) For those questions related to propellers (subject 081 07), as a simplification of the physical reality, the inflow speed into the propeller plane is taken as the aeroplane's TAS. In addition, when discussing propeller rotational direction, it will always be specified as seen from behind the propeller plane.

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
080 00 00 00	**PRINCIPLES OF FLIGHT**						
081 00 00 00	**PRINCIPLES OF FLIGHT — AEROPLANE**						
081 01 00 00	**SUBSONIC AERODYNAMICS**						
081 01 01 00	**Basics, laws and definitions**						
081 01 01 01	**Laws and definitions**						
LO	— List the SI units of measurement for mass, acceleration, weight, velocity, density, temperature, pressure, force, wing loading and power. — Define 'mass', 'force', 'acceleration' and 'weight'. — State and interpret Newton's laws. — State and interpret Newton's first law.	x	x				

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	— State and interpret Newton's second law. — State and interpret Newton's third law. — Explain air density. — List the atmospheric properties that effect air density. — Explain how temperature and pressure changes affect density. — Define 'static pressure'. — Define 'dynamic pressure'. — Define the 'formula for dynamic pressure'. — Apply the formula for a given altitude and speed. — State Bernoulli's equation. — Define 'total pressure'. — Apply the equation to a Venturi. — Describe how the IAS is acquired from the pitot-static system. — Describe the relationship between density, temperature and pressure for air. — Describe the Equation of Continuity. — Define 'IAS', 'CAS', 'EAS', 'TAS'.						
081 01 01 02	**Basics about airflow**						
LO	— Describe steady and unsteady airflow. — Explain the concept of a streamline. — Describe and explain airflow through a stream tube. — Explain the difference between two and three-dimensional airflow.	x	x				
081 01 01 03	**Aerodynamic forces and moments on aerofoils**						
LO	— Describe the force resulting from the pressure distribution around an aerofoil. — Resolve the resultant force into the components 'lift' and 'drag'. — Describe the direction of lift and drag. — Define the 'aerodynamic	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	moment'. — List the factors that affect the aerodynamic moment. — Describe the aerodynamic moment for a symmetrical aerofoil. — Describe the aerodynamic moment for a positively and negatively cambered aerofoil. — Forces and equilibrium of forces (refer to 081 08 00 00). — Define 'angle of attack'.						
081 01 01 04	**Shape of an aerofoil section**						
LO	Describe the following parameters of an aerofoil section: — leading edge; — trailing edge; — chord line; — thickness to chord ratio or relative thickness; — location of maximum thickness; — camber line; — camber; — nose radius. Describe a symmetrical and an asymmetrical aerofoil section.	x	x				
081 01 01 05	**Wing shape**						
LO	Describe the following parameters of a wing: — span; — tip and root chord; — taper ratio; — wing area; — wing planform; — mean geometric chord; — mean aerodynamic chord (MAC); — aspect ratio; — dihedral angle; — sweep angle; — wing twist; — geometric;	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	— aerodynamic; — angle of incidence. *Remark: In certain textbooks, angle of incidence is used as angle of attack. For Part-FCL theoretical-knowledge examination purposes this use is discontinued and the angle of incidence is defined as the angle between the aeroplane longitudinal axis and the wing-root chord line.*						
081 01 02 00	**Two-dimensional airflow around an aerofoil**						
081 01 02 01	**Streamline pattern**						
LO	— Describe the streamline pattern around an aerofoil. — Describe converging and diverging streamlines and their effect on static pressure and velocity. — Describe upwash and downwash.	x	x				
081 01 02 02	**Stagnation point**						
LO	— Describe the stagnation point. — Explain the effect on the stagnation point of angle-of-attack changes. — Explain local-pressure changes.	x	x				
081 01 02 03	**Pressure distribution**						
LO	— Describe pressure distribution and local speeds around an aerofoil including effects of camber and angle of attack. — Describe where the minimum local static pressure is typically situated on an aerofoil.	x	x				
081 01 02 04	**Centre of pressure and aerodynamic centre**						
LO	Explain centre of pressure and aerodynamic centre.	x	x				
081 01 02 05	**Lift and downwash**						
LO	Explain the association between lift and downwash.	x	x				

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
081 01 02 06	**Drag and wake**						
LO	— List two physical phenomena that cause drag. — Describe skin friction drag. — Describe pressure (form) drag. — Explain why drag and wake cause loss of energy (momentum).	x	x				
081 01 02 07	**Influence of angle of attack**						
LO	Explain the influence of angle of attack on lift.	x	x				
081 01 02 08	**Flow separation at high angles of attack**						
LO	Refer to 081 01 08 01.	x	x				
081 01 02 09	**The lift — α graph**						
LO	— Describe the lift and angle-of-attack graph. — Explain the significant points on the graph. — Describe lift against α graph for a symmetrical aerofoil.	x	x				
081 01 03 00	**Coefficients**						
LO	Explain why coefficients are used in general.	x	x				
081 01 03 01	**The lift coefficient C_l**						
LO	— Describe the lift formula and perform simple calculations. — Describe the $C_l - \alpha$ graph (symmetrical and positively/ negatively cambered aerofoils). — Describe the typical difference in $C_l - \alpha$ graph for fast and slow aerofoil design. — Define 'C_{lMAX}' and 'α_{stall}' on the graph.	x	x				
081 01 03 02	**The drag coefficient C_d**						
LO	— Describe the drag formula and perform simple calculations. — Discuss the effect of the shape of a body on the drag	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	coefficient. — Describe the C_l – C_d graph (aerofoil polar). — Indicate minimum drag on the graph. — Explain why the C_l–C_d ratio is important as a measure of performance. — State the normal values of C_l–C_d.						
081 01 04 00	**Three-dimensional airflow about an aeroplane**						
LO	— Define 'angle of attack.' *Remark: For theoretical-knowledge examination purposes, the angle-of-attack definition requires a reference line. This reference line for 3-D has been chosen to be the longitudinal axis and for 2-D the chord line*. — Explain the difference between the angle of attack and the attitude of an aeroplane.	x	x				
081 01 04 01	**Streamline pattern**						
LO	— Describe the general streamline pattern around the wing, tail section and fuselage. — Explain and describe the causes of spanwise flow over top and bottom surfaces. — Describe tip vortices and local α. — Explain how tip vortices vary with angle of attack. — Explain upwash and downwash due to tip vortices. — Describe spanwise lift distribution including the effect of wing planform. — Describe the causes, distribution and duration of the wake turbulence behind an aeroplane. — Describe the influence of flap deflection on the tip vortex. — List the parameters that influence wake turbulence.	x	x				

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
081 01 04 02	**Induced drag**						
LO	— Explain what causes the induced drag. — Describe the approximate formula for the induced drag coefficient. — State the factors that affect induced drag. — Describe the relationship between induced drag and total drag in the cruise. — Describe the effect of mass on induced drag at a given IAS. — Describe the means to reduce induced drag: • aspect ratio; • winglets; • tip tanks; • wing twist; • camber change. — Describe the influence of lift distribution on induced drag. — Describe the influence of tip vortices on the angle of attack. — Explain induced and effective local angle of attack. — Explain the influence of the induced angle of attack on the direction of the lift vector. — Explain the relationship between induced drag and: • speed; • aspect ratio; • wing planform; • bank angle in a horizontal coordinated turn. — Explain the induced drag coefficient. — Explain the relationship between the induced drag coefficient and the angle-of-attack or lift coefficient. — Explain the influence of induced drag on: • C_L–angle-of-attack graph, show the effect on the	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	graph when comparing high and low aspect ratio wings; • C_L–C_D (aeroplane polar), show the effect on the graph when comparing high and low aspect ratio wings; • parabolic aeroplane polar in a graph and as a formula ($C_D = C_{Dp} + kC_L^2$).						
081 01 05 00	**Total drag**						
LO	State that total drag consists of parasite drag and induced drag.	x	x				
081 01 05 01	**Parasite drag**						
LO	— List the types of drag that are included in parasite drag. — Describe form (pressure) drag. — Describe interference drag. — Describe friction drag.	x	x				
081 01 05 02	**Parasite drag and speed**						
LO	Describe the relationship between parasite drag and speed.	x	x				
081 01 05 03	**Induced drag and speed**						
LO	Refer to 081 01 04 02.	x	x				
081 01 05 04	**Intentionally left blank**						
081 01 05 05	**Total drag and speed**						
LO	— Explain the total drag–speed graph and the constituent drag components. — Indicate the speed for minimum drag.	x	x				
081 01 05 06	**Intentionally left blank**						
081 01 05 07	**The total drag–speed graph**						
LO	— Describe the effect of aeroplane gross mass on the graph. — Describe the effect of pressure altitude on: • drag–IAS graph; • drag–TAS graph.	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	— Describe speed stability from the graph. — Describe non-stable, neutral and stable IAS regions. — Explain what happens to the IAS and drag in the non-stable region if speed suddenly decreases.						
081 01 06 00	**Ground effect**						
LO	Explain what happens to the tip vortices, downwash, airflow pattern, lift and drag in ground effect.	x	x				
081 01 06 01	**Effect on C_{Di}**						
LO	— Describe the influence of ground effect on C_{Di} and induced angle of attack. — Explain the effects on entering and leaving ground effect.	x	x				
081 01 06 02	**Effect on α_{stall}**						
LO	Describe the influence of ground effect on α_{stall}.	x	x				
081 01 06 03	**Effect on C_L**						
LO	Describe the influence of ground effect on C_L.	x	x				
081 01 06 04	**Effect on take-off and landing characteristics of an aeroplane**						
LO	— Describe the influence of ground effect on take-off and landing characteristics and performance of an aeroplane. — Describe the difference between: • high and low wing characteristics; • high and low tail characteristics. — Explain the effects on static pressure measurements at the static ports when entering and leaving ground effect.	x	x				
081 01 07 00	**The relationship between lift**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	coefficient and speed in steady, straight and level flight						
081 01 07 01	**Represented by an equation**						
LO	Explain the effect on C_L during speed increase/decrease in steady, straight and level flight, and perform simple calculations.	x	x				
081 01 07 02	**Represented by a graph**						
LO	Explain, by using a graph, the effect on speed of C_L changes at a given weight.	x	x				
081 01 08 00	**The stall**						
081 01 08 01	**Flow separation at increasing angles of attack**						
LO	— Define the 'boundary layer'. — Describe the thickness of a typical boundary layer. — List the factors that affect thickness. — Describe the laminar layer. — Describe the turbulent layer. — Define the 'transition point'. — List the differences between laminar and turbulent boundary layers. — Explain why the laminar boundary layer separates easier than the turbulent one. — List the factors that slow down the airflow over the aft part of an aerofoil, as the angle of attack increases. — Define the 'separation point' and describe its location as a function of angle of attack. — Define the 'critical stall angle of attack'. — Describe the influence of increasing the angle of attack on: • the forward stagnation point; • the pressure distribution;	x	x				

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	• the location of the centre of pressure (straight and swept back wing); • C_L and L; • C_D and D; • the pitching moment (straight and swept back wing); • the downwash at the horizon stabiliser. — Explain what causes the possible natural buffet on the controls in a pre-stall condition. — Describe the effectiveness of the flight controls in a pre-stall condition. — Describe and explain the normal post-stall behaviour of a wing/aeroplane; — Describe the dangers of using the controls close to the stall.						
081 01 08 02	**The stall speed**						
LO	— Explain V_{S0}, V_{S1}, V_{SR}, V_{S1g}. — Solve the 1G stall speed from the lift formula. — Describe and explain the influence of the following parameters on stall speed: • centre of gravity; • thrust component; • slipstream; • wing loading; • mass; • wing contamination; • angle of sweep; • altitude (for compressibility effects, see 081 02 03 02). — Define the 'load factor n'. — Explain why the load factor increases in a turn. — Explain why the load factor increases in a pull-up and decreases in a push-over manoeuvre. — Describe and explain the influence of the 'load factor n' on stall speed.	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	— Explain the expression 'accelerated stall'. *Remark: Sometimes accelerated stall is also erroneously referred to as high-speed stall. This latter expression will not be used for subject 081.* — Calculate the change of stall speed as a function of the load factor. — Calculate the increase of stall speed in a horizontal coordinated turn as a function of bank angle. — Calculate the change of stall speed as a function of the gross mass.						
081 01 08 03	**The initial stall in span-wise direction**						
LO	— Explain the initial stall sequence on the following platforms: • elliptical; • rectangular; • moderate and high taper; • sweepback or delta. — Explain the influence of geometric twist (wash out) and aerodynamic twist. — Explain the influence of deflected ailerons. — Explain the influence of fences, vortilons, saw teeth, vortex generators.	x	x				
081 01 08 04	**Stall warning**						
LO	— Explain why stall warning is necessary. — Explain when aerodynamic and artificial stall warnings are used. — Explain why CS-23 and CS-25 require a margin to stall speed. — Describe: • buffet; • stall strip; • flapper switch (leading-edge stall-warning vane);	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	• angle-of-attack vane; • angle-of-attack probe; • stick shaker. — Describe the recovery after: • stall warning; • stall; • stick-pusher actuation.						
081 01 08 05	**Special phenomena of stall**						
LO	— Describe the basic stall requirements for transport category aeroplanes. — Explain the difference between power-off and power-on stalls and recovery. — Describe stall and recovery in a climbing and descending turn. — Describe the effect on stall and recovery characteristics of: • wing sweep (consider both forward and backward sweep); • T-tailed aeroplane; • canards. — Describe super-stall or deep-stall. — Describe the philosophy behind the stick-pusher system. — Explain the effect of ice, frost or snow on the stagnation point. — Explain the absence of stall warning. — Explain the abnormal behaviour of the stall. — Describe and explain cause and effects of the stabiliser stall (negative tail stall). — Describe when to expect in-flight icing. — Explain how the effect is changed when retracting/ extending lift augmentation devices. — Describe how to recover from a stall after a configuration change caused by in-flight icing. — Explain the effect of a	x	x				

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	contaminated wing. — Explain what 'on-ground' icing is. — Describe the aerodynamic effects of de-icing/anti-ice fluid after the holdover time has been reached. — Describe the aerodynamic effects of heavy tropical rain on stall speed and drag. — Explain how to avoid spins. — List the factors that cause a spin to develop. — Describe spin development, recognition and recovery. — Describe the differences in recovery techniques for aeroplanes that have different mass distributions between the wings and the fuselage.						
081 01 09 00	**C_{LMAX} augmentation**						
081 01 09 01	**Trailing-edge flaps and the reasons for use in take-off and landing**						
LO	— Describe trailing-edge flaps and the reasons for their use during take-off and landing. — Identify the different types of trailing-edge flaps given a relevant diagram: • split flaps; • plain flaps; • slotted flaps; • fowler flaps. — Describe their effect on wing geometry. — Describe how the wing's effective camber increases. — Describe how the effective chord line differs from the normal chord line. — Describe their effect on: • the location of centre of pressure; • pitching moments;	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	• stall speed. — Compare their influence on the C_L–α graph: • indicate the variation in C_L at any given angle of attack; • indicate the variation in C_D at any given angle of attack; • indicate their effect on C_{LMAX}; • indicate their effect on the stall or critical angle of attack; • indicate their effect on the angle of attack at a given C_L. — Compare their influence on the C_L–C_D graph: • indicate how the $(C_L/C_D)_{MAX}$ differs from that of a clean wing. — Explain the influence of trailing-edge flap deflection on the glide angle. — Describe flap asymmetry: • explain the effect on aeroplane controllability. — Describe trailing-edge flap effect on take-off and landing: • explain the advantages of lower-nose attitudes; • explain why take-off and landing speeds/distances are reduced.						
081 01 09 02	**Leading-edge devices and the reasons for their use in take-off and landing**						
LO	— Describe leading-edge high-lift devices. — Identify the different types of leading-edge high-lift devices given a relevant diagram: • Krueger flaps; • variable camber flaps; • slats.	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	— State their effect on wing geometry. — Describe the function of the slot. — Describe how the wing's effective camber increases. — Describe how the effective chord line differs from the normal chord line. — State their effect on the stall speed, also in comparison with trailing edge flaps. — Compare their influence on the C_L–α graph, compared with trailing-edge flaps and a clean wing: • indicate the effect of leading-edge devices on C_{LMAX}; • explain how the C_L curve differs from that of a clean wing; • indicate the effect of leading-edge devices on the stall or critical angle of attack. — Compare their influence on the C_L–C_D graph; — Describe slat asymmetry: • describe the effect on aeroplane controllability. — Explain the reasons for using leading-edge high-lift devices on take-off and landing: • explain the disadvantage of increased nose-up attitudes; • explain why take-off and landing speeds/distances are reduced.						
081 01 09 03	**Vortex generators**						
LO	— Explain the purpose of vortex generators. — Describe their basic operating principle. — State their advantages and disadvantages.	x	x				
081 01 10 00	**Means to reduce the C_L–C_D ratio**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
081 01 10 01	**Spoilers and the reasons for use in the different phases of flight**						
LO	— Describe the aerodynamic functioning of spoilers: • roll spoilers; • flight spoilers (speed brakes); • ground spoilers (lift dumpers). — Describe the effect of spoilers on the C_L–α graph and stall speed. — Describe the influence of spoilers on the C_L–C_D graph and lift–drag ratio.	x	x				
081 01 10 02	**Speed brakes and the reasons for use in the different phases of flight**						
LO	— Describe speed brakes and the reasons for use in the different phases of flight. — State their influence on the C_L–C_D graph and lift–drag ratio. — Explain how speed brakes increase parasite drag. — Describe how speed brakes affect the minimum drag speed. — Describe their effect on rate and angle of descent.	x	x				
081 01 11 00	**The boundary layer**						
081 01 11 01	**Different types**						
LO	Refer to 081 01 08 01.	x	x				
081 01 11 02	**Their advantages and disadvantages on pressure drag and friction drag**						
081 01 12 00	**Aerodynamic degradation**						
081 01 12 01	**Ice and other contaminants**						
LO	— Describe the locations on an aeroplane where ice build-up will occur during flight. — Explain the aerodynamic effects of ice and other contaminants on: • lift (maximum lift coefficient);	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	• drag; • stall speed; • stalling angle of attack; • stability and controllability. — Explain the aerodynamic effects of icing on the various phases during take-off.						
081 01 12 02	**Deformation and modification of airframe, ageing aeroplanes**						
LO	— Describe the effect of airframe deformation and modification of an ageing aeroplane on aeroplane performance. — Explain the effect on boundary layer condition of an ageing aeroplane.	x	x				
081 02 00 00	**HIGH-SPEED AERODYNAMICS**						
081 02 01 00	**Speeds**						
081 02 01 01	**Speed of sound**						
LO	— Define 'speed of sound'. — Explain the variation of the speed of sound with altitude. — Describe the influence of temperature on the speed of sound.	x					
081 02 01 02	**Mach number**						
LO	Define 'Mach number as a function of TAS and speed of sound'.	x					
081 02 01 03	**Influence of temperature and altitude on Mach number**						
LO	— Explain the absence of change of Mach number with varying temperature at constant flight level and calibrated airspeed. — Referring to 081 08 01 02 and 081 08 01 03, explain the relationship of Mach number, TAS and IAS during climb and descent at constant Mach number and IAS, and explain variation of lift coefficient, angle of attack, pitch and	x					

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	flight-path angle; — Referring to 081 06 01 04 and 081 06 01 05, explain that VMO can be exceeded during a descent at constant Mach number and that MMO can be exceeded during a climb at constant IAS.						
081 02 01 04	**Compressibility**						
LO	— State that compressibility means that density can change along a streamline. — Describe how the streamline pattern changes due to compressibility. — State that Mach number is a measure of compressibility.	x					
081 02 01 05	**Subdivision of aerodynamic flow**						
LO	— List the subdivision of aerodynamic flow: • subsonic flow; • transonic flow; • supersonic flow. — Describe the characteristics of the flow regimes listed above. — State that transport aeroplanes normally cruise at Mach numbers above M_{crit}.	x					
081 02 02 00	**Shock waves**						
LO	Define a 'shock wave'.	x					
081 02 02 01	**Normal shock waves**						
LO	Describe a normal shock wave with respect to changes in: — static temperature; — static and total pressure; — velocity; — local speed of sound; — Mach number; — density. Describe a normal shock wave with respect to orientation relative to the wing surface.	x					

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	Explain the influence of increasing Mach number on a normal shock wave, at positive lift, with respect to: — strength; — length; — position relative to the wing; — second shock wave at the lower surface. Explain the influence of angle of attack on shock-wave intensity at constant Mach number. Discuss the bow wave.						
081 02 02 02	**Oblique shock waves**						
LO	Describe an oblique shock wave with respect to changes in: — static temperature; — static and total pressure; — velocity; — local speed of sound; — Mach number; — density. Compare the characteristics of normal and oblique shock waves.	x					
081 02 02 03	**Mach cone**						
LO	Define 'Mach angle μ' with a formula and perform simple calculations. Identify the Mach-cone zone of influence of a pressure disturbance due to the presence of the aeroplane. Explain 'sonic boom'.	x					
081 02 03 00	**Effects of exceeding M_{crit}**						
081 02 03 01	**M_{crit}**						
LO	Define 'M_{crit}'. Explain how a change in angle of attack influences M_{crit}.	x					
081 02 03 02	**Effect on lift**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Describe the behaviour of lift coefficient CL versus Mach number at constant angle of attack. Explain shock-induced separation, shock stall, and describe its relationship with Mach buffet. Define 'shock stall'. *Remark: For theoretical-knowledge examination purposes, the following description is used for shock stall: Shock stall occurs when the lift coefficient, as a function of Mach number, reaches its maximum value (for a given angle of attack).* Describe the consequences of exceeding M_{crit} with respect to: — gradient of the C_L–α graph; — C_{LMAX} (stall speed). Explain the change in stall speed (IAS) with altitude. Discuss the effect on critical or stalling angle of attack.	x					
081 02 03 03	**Effect on drag**						
LO	Describe wave drag. Describe the behaviour of drag coefficient C_D versus Mach number at constant angle of attack. Explain the effect of Mach number on the C_L–C_D graph. Define 'drag divergence Mach number' and explain the relation with M_{crit}.	x					
081 02 03 04	**Effect on pitching moment**						
LO	Discuss the effect of Mach number on the location of centre of pressure and	x					

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	aerodynamic centre. Explain 'tuck under' effect. List the methods of compensating for tuck under effect. Discuss the aerodynamic functioning of the Mach trim system. Discuss the corrective measures if the Mach trim fails.						
081 02 03 05	**Effect on control effectiveness**						
LO	Discuss the effects on the functioning of control surfaces.	x					
081 02 04 00	**Buffet onset**						
LO	Explain the concept of buffet margin and describe the influence of the following parameters: — angle of attack; — Mach number; — pressure altitude; — mass; — load factor; — angle of bank; — CG location. Explain how the buffet onset boundary chart can be used to determine manoeuvre capability. Describe the effect of exceeding the speed for buffet onset. Explain aerodynamic ceiling and 'coffin corner'. Explain the concept of the '1.3G' altitude. Find (using an example graph): — buffet free range; — aerodynamic ceiling at a given mass; — load factor and bank angle at which buffet occurs at a given	x					

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	mass, Mach number and pressure altitude.						
081 02 05 00	**Means to influence M_{crit}**						
081 02 05 01	**Wing sweep**						
LO	Explain the influence of the angle of sweep on: — M_{crit}; — effective thickness/chord change or velocity component perpendicular to the quarter chord line. Describe the influence of the angle of sweep at subsonic speed on: — C_{LMAX}; — efficiency of high-lift devices. — pitch-up stall behaviour. Discuss the effect of wing sweep on drag.	x					
081 02 05 02	**Aerofoil shape**						
LO	Explain the use of thin aerofoils with reduced camber. Explain the main purpose of supercritical aerofoils. Identify the shape characteristics of a supercritical aerofoil shape. Explain the advantages and disadvantages of supercritical aerofoils for wing design.	x					
081 02 05 03	**Vortex generators**						
LO	Explain the use of vortex generators as a means to avoid or restrict flow separation.	x					
081 02 05 04	**Area ruling**						
LO	Explain area ruling in aeroplane design.	x					

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
081 03 00 00	**Intentionally left blank**						
081 04 00 00	**STABILITY**						
081 04 01 00	**Static and dynamic stability**						
081 04 01 01	**Basics and definitions**						
LO	Define 'static stability': — identify a statically stable, neutral and unstable condition (positive, neutral and negative static stability). Explain manoeuvrability. Explain why static stability is the opposite of manoeuvrability. Define 'dynamic stability': — identify a dynamically stable, neutral and unstable motion (positive, neutral and negative dynamic stability); — identify periodic and aperiodic motion. Explain what combinations of static and dynamic stability will return an aeroplane to the equilibrium state after a disturbance.	x	x				
081 04 01 02	**Precondition for static stability**						
LO	Explain an equilibrium of forces and moments as the condition for the concept of static stability.	x	x				
081 04 01 03	**Sum of forces**						
LO	Identify the forces considered in the equilibrium of forces.	x	x				
081 04 01 04	**Sum of moments**						
LO	Identify the moments about all three axes considered in the equilibrium of moments. Discuss the effect of sum of moments	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	not being zero.						
081 04 02 00	**Intentionally left blank**						
081 04 03 00	**Static and dynamic longitudinal stability**						
081 04 03 01	**Methods for achieving balance**						
LO	Explain the stabiliser and the canard as the means to satisfy the condition of nullifying the total sum of the moments about the lateral axis. Explain the influence of the location of the wing centre of pressure relative to the centre of gravity on the magnitude and direction of the balancing force on stabiliser and canard. Explain the influence of the indicated airspeed on the magnitude and direction of the balancing force on stabiliser and canard. Explain the influence of the balancing force on the magnitude of the wing/fuselage lift. Explain the use of the elevator deflection or stabiliser angle for the generation of the balancing force. Explain the elevator deflection required to balance thrust changes.	x	x				
081 04 03 02	**Static longitudinal stability**						
LO	Explain the changes in aerodynamic forces when varying angle of attack for a static longitudinally stable aeroplane. Discuss the effect of CG location on pitch manoeuvrability.	x	x				
081 04 03 03	**Neutral point**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Define 'neutral point'. Explain why the location of the neutral point is only dependent on the aerodynamic design of the aeroplane.	x	x				
081 04 03 04	**Factors affecting neutral point**						
LO	Indicate the location of the neutral point relative to the locations of the aerodynamic centre of the wing and tail/canard. Explain the influence of the downwash variations with angle-of-attack variation on the location of the neutral point. Explain the contribution of engine nacelles.	x	x				
081 04 03 05	**Location of centre of gravity**						
LO	Explain the influence of the CG location on static longitudinal stability of the aeroplane. Explain the CG forward and aft limits with respect to: — longitudinal control forces; — elevator effectiveness; — stability. Define 'static margin'.	x	x				
081 04 03 06	**The C_m–α graph**						
LO	Define the 'aerodynamic pitching moment coefficient (C_m)'. Describe the C_m–α graph with respect to: — positive and negative sign; — linear relationship; — angle of attack for equilibrium state; — relationship between the slope of the graph and static stability.	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
081 04 03 07	**Factors affecting the C_m–α graph**						
LO	Explain: — the effect on the C_m–α graph of a shift of CG in the forward and aft direction; — the effect on the C_m–α graph when the elevator is moved up or down; — the effect on the C_m–α graph when the trim is moved; — the effect of the wing contribution and how it is affected by CG location; — the effect of the fuselage contribution and how it is affected by CG location; — the tail contribution; — the effect of aerofoil camber change.	x	x				
081 04 03 08	**The elevator position versus speed graph (IAS)**						
LO	Describe the elevator position speed graph. Explain: — the gradient of the elevator position speed graph; — the influence of the airspeed on the stick position stability.	x	x				
081 04 03 09	**Factors affecting the elevator position–speed graph**						
LO	Explain the contribution on the elevator position–speed graph of: — the location of centre of gravity; — the trim (trim tab and stabiliser trim); — high-lift devices.	x	x				
081 04 03 10	**The stick force versus speed graph (IAS)**						
LO	Define the 'stick force speed graph'. Describe the minimum gradient for	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	stick force versus speed that is required for certification according to CS-23 and CS-25. Explain the importance of the stick force gradient for good flying qualities of an aeroplane. Identify the trim speed in the stick force speed graph. Explain how a pilot perceives stable static longitudinal stick force stability.						
081 04 03 11	**Factors affecting the stick force versus speed graph**						
LO	Explain the contribution of: — the location of the centre of gravity; — the trim (trim tab and stabiliser trim); — down spring; — bob weight; — friction.	x	x				
LO	Explain the contribution of Mach number — Ref. 081 02 03 04.	x					
081 04 03 12	**The manoeuvring stability/stick force per G**						
LO	Define the 'stick force per G'. Explain why: — the stick force per G has a prescribed minimum and maximum value; — the stick force per G decreases with pressure altitude at the same indicated airspeed.	x	x				
081 04 03 13	**Intentionally left blank**						
081 04 03 14	**Factors affecting the manoeuvring stability/stick force per G**						
LO	Explain the influence on stick force per G of: — CG location;	x	x				

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	— trim setting; — a down spring in the control system; — a bob weight in the control system.						
081 04 03 15	**Stick force per G and the limit-load factor**						
LO	Explain why the prescribed minimum and maximum values of the stick force per G are dependent on the limit-load factor. Calculate the stick force to achieve a certain load factor at a given manoeuvre stability.	x	x				
081 04 03 16	**Dynamic longitudinal stability**						
LO	Describe the phugoid and short-period motion in terms of period, damping, variations (if applicable) in speed, altitude and angle of attack. Explain why short-period motion is more important for flying qualities than the phugoid. Define and describe 'pilot-induced oscillations'. Explain the effect of high altitude on dynamic stability. Describe the influence of the CG location on the dynamic longitudinal stability of the aeroplane.	x	x				
081 04 04 00	**Static directional stability**						
LO	Define 'static directional stability'. Explain the effects of static directional stability being too weak or too strong.	x	x				
081 04 04 01	**Sideslip angle β**						
LO	Define 'sideslip angle'. Identify β as the symbol used for the	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	sideslip angle.						
081 04 04 02	**Yaw-moment coefficient C_n**						
LO	Define the 'yawing-moment coefficient C_n'. Define the relationship between C_n and β for an aeroplane with static directional stability.	x	x				
081 04 04 03	**C_n–β graph**						
LO	Explain why: — C_n depends on the angle of sideslip; — C_n equals zero for that angle of sideslip that provides static equilibrium about the aeroplane's normal axis; — if no asymmetric engine thrust, flight control or loading condition prevails, the equilibrium angle of sideslip equals zero. Identify how the slope of the C_n–β graph is a measure for static directional stability.	x	x				
081 04 04 04	**Factors affecting static directional stability**						
LO	Describe how the following aeroplane components contribute to static directional stability: — wing; — fin; — dorsal fin; — ventral fin; — angle of sweep of the wing; — angle of sweep of the fin; — fuselage at high angles of attack; — strakes. Explain why both the fuselage and	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	the fin contribution reduce static directional stability when the CG moves aft.						
081 04 05 00	**Static lateral stability**						
LO	Define 'static lateral stability'. Explain the effects of static lateral stability being too weak or too strong.	x	x				
081 04 05 01	**Bank angle Ø**						
LO	Define 'bank angle Ø'.	x	x				
081 04 05 02	**The roll-moment coefficient C_l**						
LO	Define the 'roll-moment coefficient C_l'.	x	x				
081 04 05 03	**Contribution of sideslip angle β**						
LO	Explain how without coordination the bank angle creates sideslip angle.	x	x				
081 04 05 04	**The C_l–β graph**						
LO	Describe C_l–β graph. Identify the slope of the C_l–β graph as a measure for static lateral stability.	x	x				
081 04 05 05	**Factors affecting static lateral stability**						
LO	Explain the contribution to the static lateral stability of: — dihedral, anhedral; — high wing, low wing; — sweep angle of the wing; — ventral fin; — vertical tail. Define 'dihedral effect'.	x	x				
081 04 05 06	**Intentionally left blank**						
081 04 06 00	**Dynamic lateral/directional stability**						
081 04 06 01	**Effects of asymmetric propeller**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	slipstream						
081 04 06 02	**Tendency to spiral dive**						
LO	Explain how lateral and directional stability are coupled. Explain how high-static directional stability and a low-static lateral stability may cause spiral divergence (unstable spiral dive), and under which conditions the spiral dive mode is neutral or stable. Describe an unstable spiral dive mode with respect to deviations in speed, bank angle, nose low-pitch attitude and decreasing altitude.	x	x				
081 04 06 03	**Dutch roll**						
LO	Describe Dutch roll. Explain: — why Dutch roll occurs when the static lateral stability is large compared with static directional stability; — the condition for a stable, neutral or unstable Dutch roll motion; — the function of the yaw damper; — the actions to be taken in case of non-availability of the yaw damper.	x	x				
LO	State the effect of Mach number on Dutch roll.	x					
081 04 06 04	**Effects of altitude on dynamic stability**						
LO	Explain that increased pressure altitude reduces dynamic lateral/directional stability.	x	x				
081 05 00 00	**CONTROL**						
081 05 01 00	**General**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
081 05 01 01	**Basics, the three planes and three axes**						
LO	Define: — lateral axis; — longitudinal axis; — normal axis. Define: — pitch angle; — bank angle; — yaw angle. Describe the motion about the three axes. Name and describe the devices that control these motions.	x	x				
081 05 01 02	**Camber change**						
LO	Explain how camber is changed by movement of a control surface.	x	x				
081 05 01 03	**Angle-of-attack change**						
LO	Explain the influence of local angle-of-attack change by movement of a control surface.	x	x				
081 05 02 00	**Pitch (longitudinal) control**						
081 05 02 01	**Elevator/all-flying tails**						
LO	Explain the working principle of the elevator/all-flying tail and describe its function. Describe the loads on the tailplane over the whole speed range.	x	x				
081 05 02 02	**Downwash effects**						
LO	Explain the effect of downwash on the tailplane angle of attack. Explain in this context the use of a T-tail or stabiliser trim.	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
081 05 02 03	**Ice on tail**						
LO	Explain how ice can change the aerodynamic characteristics of the tailplane. Explain how this can affect the tail's proper function.	x	x				
081 05 02 04	**Location of centre of gravity**						
LO	Explain the relationship between elevator deflection and CG location to produce a given aeroplane response. Explain the effect of forward CG limit on pitch control.	x	x				
081 05 02 05	**Moments due to engine thrust**						
LO	Describe the effect of engine thrust on pitching moments for different engine locations.	x	x				
081 05 03 00	**Yaw (directional) control**						
LO	Explain the working principle of the rudder and describe its function. — State the relationship between rudder deflection and the moment about the normal axis; — Describe the effect of sideslip on the moment about the normal axis.	x	x				
081 05 03 01	**Rudder limiting**						
LO	Explain why and how rudder deflection is limited on transport aeroplanes.	x					
081 05 04 00	**Roll (lateral) control**						
081 05 04 01	**Ailerons**						
LO	Explain the functioning of ailerons. Describe the adverse effects of ailerons. (Refer to 081 05 04 04 and 081 06 01 02)	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	Explain in this context the use of inboard and outboard ailerons. Explain outboard-aileron lockout and conditions under which this feature is used. Describe the use of aileron deflection in normal flight, flight with sideslip, crosswind landings, horizontal turns, flight with one engine out. Define 'roll rate'. List the factors that affect roll rate. Flaperons, aileron droop.						
081 05 04 02	**Intentionally left blank**						
081 05 04 03	**Spoilers**						
LO	Explain how spoilers can be used to control the rolling movement in combination with or instead of the ailerons.	x	x				
081 05 04 04	**Adverse yaw**						
LO	Explain how the use of ailerons induces adverse yaw.	x	x				
081 05 04 05	**Means to avoid adverse yaw**						
LO	Explain how the following reduce adverse yaw: — Frise ailerons; — differential aileron deflection; — rudder aileron cross-coupling; — roll spoilers.	x	x				
081 05 05 00	**Roll/yaw interaction**						
LO	Explain the secondary effect of roll. Explain the secondary effect of yaw.	x	x				
081 05 06 00	**Means to reduce control forces**						
081 05 06 01	**Aerodynamic balance**						
LO	Describe the purpose of aerodynamic	x	x				

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	balance. Describe the working principle of the nose and horn balance. Describe the working principle of internal balance. Describe the working principle and the application of: — balance tab; — anti-balance tab; — spring tab; — servo tab.						
081 05 06 02	**Artificial means**						
LO	Describe fully powered controls. Describe power-assisted controls. Explain why artificial feel is required. Explain the inputs to an artificial feel system.	x	x				
081 05 07 00	**Mass balance**						
LO	Refer to 081 06 01 01 for mass balance. Refer to 081 04 03 11 and 081 04 03 14 for bob weight.	x	x				
081 05 08 00	**Trimming**						
081 05 08 01	**Reasons to trim**						
LO	State the reasons for trimming devices. Explain the difference between a trim tab and the various balance tabs.	x	x				
081 05 08 02	**Trim tabs**						
LO	Describe the working principle of a trim tab including cockpit indications.	x	x				
081 05 08 03	**Stabiliser trim**						
LO	Explain the advantages and disadvantages of a stabiliser trim	x	x				

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	compared with a trim tab. Explain elevator deflection when the aeroplane is trimmed in the case of fully powered and power-assisted pitch controls. Explain the factors influencing stabiliser setting. Explain the influence of take-off stabiliser trim setting on rotation characteristics and stick force during take-off rotation at extremes of CG position. Discuss the effects of jammed and runaway stabiliser. Explain the landing considerations with a jammed stabiliser.						
081 06 00 00	**LIMITATIONS**						
081 06 01 00	**Operating limitations**						
081 06 01 01	**Flutter**						
LO	Describe the phenomenon of flutter and list the factors: — elasticity; — backlash; — aeroelastic coupling; — mass distribution; — structural properties — - IAS. List the flutter modes of an aeroplane: - wing. - tailplane. - fin. - control surfaces including tabs. Describe the use of mass balance to alleviate the flutter problem by adjusting the mass distribution:	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	— wing-mounted pylons; — control surface mass balance. List the possible actions in the case of flutter in flight.						
081 06 01 02	**Aileron reversal**						
LO	Describe the phenomenon of aileron reversal: — at low speeds; — at high speeds. Describe the aileron reversal speed in relationship to V_{NE} and V_{NO}.	x	x				
081 06 01 03	**Landing gear/flap operating**						
LO	Describe the reason for flap/landing gear limitations. — define 'V_{LO}'; — define 'V_{LE}'. Explain why there is a difference between V_{LO} and V_{LE} in the case of some aeroplane types. Define 'V_{FE}'. Describe flap design features to prevent overload.	x	x				
081 06 01 04	**V_{MO}, V_{NO}, V_{NE}**						
LO	Define 'V_{MO}', 'V_{NO}', 'V_{NE}'. Describe the differences between V_{MO}, V_{NO} and V_{NE}. Explain the dangers of flying at speeds close to V_{NE}.	x	x				
081 06 01 05	**M_{MO}**						
LO	Define 'M_{MO}' and state its limiting factors.	x					
081 06 02 00	**Manoeuvring envelope**						
081 06 02 01	**Manoeuvring-load diagram**						
LO	Describe the manoeuvring-load	x	x				

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	diagram. Define limit and ultimate load factor and explain what can happen if these values are exceeded. Define ‘V_A’, ‘V_C’, ‘V_D’. Identify the varying features on the diagram: — load factor ‘n’; — speed scale, equivalent airspeed, EAS; — C_{LMAX} boundary; — accelerated stall speed (refer to 081 01 08 02). Describe the relationship between V_{MO} and V_C. State all the manoeuvring limit load factors applicable to CS-23 and CS-25 aeroplanes. Explain the relationship between V_A and V_S in a formula. Explain the adverse consequences of exceeding V_A.						
081 06 02 02	**Factors affecting the manoeuvring-load diagram**						
LO	State the relationship of mass to: — load factor limits; — accelerated stall speed limit; — V_A and V_C. Explain the relationship between V_A, aeroplane mass and altitude. Calculate the change of V_A with changing mass.	x	x				
LO	Describe the effect of altitude on Mach number, with respect to limitations. Explain why V_A loses significance at higher altitude where compressibility effects occur.	x					

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	Define 'M$_C$' and 'M$_D$' and their relation with V_C and V_D.						
081 06 03 00	**Gust envelope**						
081 06 03 01	**Gust-load diagram**						
LO	Recognise a typical gust-load diagram. Identify the various features shown on the diagram: — gust-load factor 'n'; — speed scale, equivalent airspeed and EAS; — C_{LMAX} boundary; — vertical gust velocities; — relationship of V_B to V_C and V_D. — gust limit load factor. Define 'V_{RA}', 'V_B'. Discuss considerations for the selection of this speed. Explain the adverse effects on the aeroplane when flying in turbulence.	x	x				
081 06 03 02	**Factors affecting the gust-load diagram.**						
LO	Explain the relationship between the gust-load factor, lift-curve slope, density ratio, wing loading, EAS and equivalent vertical sharp-edged gust velocity and perform relevant calculations.	x	x				
081 07 00 00	**PROPELLERS**						
081 07 01 00	**Conversion of engine torque to thrust**						
LO	Explain the resolution of aerodynamic force on a propeller blade element into lift and drag or into thrust and torque. Describe propeller thrust and torque	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	and their variation with IAS.						
081 07 01 01	**Relevant propeller parameters**						
LO	Describe the geometry of a typical propeller blade element at the reference section: — blade chord line; — propeller rotational velocity vector; — true-airspeed vector; — blade angle of attack; — pitch or blade angle; — advance or helix angle; — define 'geometric pitch', 'effective pitch' and 'propeller slip'. *Remark: For theoretical-knowledge examination purposes, the following definition is used for geometric pitch: the theoretical distance a propeller would advance in one revolution at zero blade angle of attack.* Define 'fine and coarse pitch'.	x	x				
081 07 01 02	**Blade twist**						
LO	Define 'blade twist'. Explain why blade twist is necessary.	x	x				
081 07 01 03	**Fixed pitch and variable pitch/constant speed**						
LO	List the different types of propellers: — fixed pitch; — adjustable pitch or variable pitch (non-governing); — variable pitch (governing)/ constant speed. Discuss the advantages and disadvantages of fixed-pitch and constant-speed propellers. Discuss climb and cruise propellers. Explain the relationship between blade angle, blade angle of attack and airspeed for fixed and variable pitch	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	propellers. Given a diagram, explain the forces acting on a rotating blade element in normal, feathered, windmilling and reverse operation. Explain the effects of changing propeller pitch at constant IAS.						
081 07 01 04	**Propeller efficiency versus speed**						
LO	Define 'propeller efficiency'. Explain the relationship between propeller efficiency and speed (TAS). Plot propeller efficiency against speed for the types of propellers listed in 081 07 01 03 above. Explain the relationship between blade angle and thrust.	x	x				
081 07 01 05	**Effects of ice on propeller**						
LO	Describe the effects of ice on a propeller.	x	x				
081 07 02 00	**Engine failure**						
081 07 02 01	**Windmilling drag**						
LO	List the effects of an inoperative engine on the performance and controllability of an aeroplane: — thrust loss/drag increase; — influence on yaw moment during asymmetric power.	x	x				
081 07 02 02	**Feathering**						
LO	Explain the reasons for feathering and the effect on performance and controllability. Influence on yaw moment during asymmetric power.	x	x				
081 07 03 00	**Design features for power**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	absorption						
LO	Describe the factors of propeller design that increase power absorption.	x	x				
081 07 03 01	**Aspect ratio of blade**						
LO	Define 'blade-aspect ratio'.	x	x				
081 07 03 02	**Diameter of propeller**						
LO	Explain the reasons for restricting propeller diameter.	x	x				
081 07 03 03	**Number of blades**						
LO	Define 'solidity'. Describe the advantages and disadvantages of increasing the number of blades.	x	x				
081 07 03 04	**Propeller noise**						
LO	Explain how propeller noise can be minimised.	x	x				
081 07 04 00	**Secondary effects of propellers**						
081 07 04 01	**Torque reaction**						
LO	Describe the effects of engine/propeller torque. Describe the following methods for counteracting engine/propeller torque: — counter-rotating propellers; — contra-rotating propellers.	x	x				
081 07 04 02	**Gyroscopic precession**						
LO	Describe what causes gyroscopic precession. Describe the effect on the aeroplane due to the gyroscopic effect.	x	x				
081 07 04 03	**Asymmetric slipstream effect**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Describe the possible asymmetric effects of the rotating propeller slipstream.	x	x				
081 07 04 04	**Asymmetric blade effect**						
LO	Explain the asymmetric blade effect (also called P factor). Explain influence of direction of rotation on critical engine on twin engine aeroplanes.	x	x				
081 08 00 00	**FLIGHT MECHANICS**						
081 08 01 00	**Forces acting on an aeroplane**						
081 08 01 01	**Straight horizontal steady flight**						
LO	Describe the forces acting on an aeroplane in straight horizontal steady flight. List the four forces and state where they act. Explain how the four forces are balanced. Describe the function of the tailplane.	x	x				
081 08 01 02	**Straight steady climb**						
LO	Define 'γ flight-path angle'. Describe the relationship between pitch attitude, flight-path angle and angle of attack for the zero-wind, zero-bank and sideslip conditions. Describe the forces acting on an aeroplane in a straight steady climb. Name the forces parallel and perpendicular to the direction of flight. — Apply the formula relating to the parallel forces ($T = D + W \sin \gamma$).	x	x				

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	— Apply the formula relating to the perpendicular forces (L = W cos γ). Explain why thrust is greater than drag. Explain why lift is less than weight. Explain the formula (for small angles) giving the relationship between flight-path angle, thrust, weight and lift–drag ratio, and use this formula for simple calculations. Explain how IAS, angle of attack and flight-path angle change in a climb performed with constant pitch attitude and normal thrust decay with altitude.						
081 08 01 03	**Straight steady descent**						
LO	Describe the forces acting on an aeroplane in a straight steady descent. Name the forces parallel and perpendicular to the direction of flight. — Apply the formula parallel to the direction of flight (T = D – W sin γ). — Apply the formula relating to the perpendicular forces (L = W cos γ). Explain why lift is less than weight. Explain why thrust is less than drag.	x	x				
081 08 01 04	**Straight steady glide**						
LO	Describe the forces acting on an aeroplane in a straight steady glide. Name the forces parallel and perpendicular to the direction of	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	flight. — Apply the formula for forces parallel to the direction of flight (D = W sin γ); — Apply the formula for forces perpendicular to the direction of flight (L = W cos γ). Describe the relationship between the glide angle and the lift–drag ratio. Describe the relationship between angle of attack and the best lift–drag ratio. Explain the effect of wind component on glide angle, duration and distance. Explain the effect of mass change on glide angle, duration and distance. Explain the effect of configuration change on glide angle, duration and distance. Describe the relation between TAS and sink rate including minimum glide angle and minimum sink rate.						
081 08 01 05	**Steady coordinated turn**						
LO	Describe the forces acting on an aeroplane in a steady coordinated turn. Resolve the forces acting horizontally and vertically during a coordinated turn (tan $\phi = \frac{V^2}{gR}$). Describe the difference between a coordinated and an uncoordinated turn and explain how to correct an uncoordinated turn using turn and slip indicator. Explain why the angle of bank is independent of mass and only	x	x				

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	depends on TAS and radius of turn. Resolve the forces to show that for a given angle of bank the radius of turn is determined solely by airspeed ($\tan \phi = \frac{V^2}{gR}$). Calculate the turn radius, load factor and the time for a complete turn for relevant parameters given for a steady turn. Discuss the effects of bank angle on: — load factor; — angle of attack; — thrust; — drag. Define 'angular velocity'. Define 'rate of turn' and 'rate-one turn'. Explain the influence of TAS on rate of turn at a given bank angle.						
081 08 02 00	**Asymmetric thrust**						
LO	Describe the effects on the aeroplane during flight with asymmetric thrust including both jet engine and propeller-driven aeroplanes. Discuss critical engine, include effect of crosswind when on the ground. Explain effect of steady asymmetric flight on a conventional (ball) slip indicator.	x	x				
081 08 02 01	**Moments about the normal axis**						
LO	Describe the moments about the normal axis. Explain the yawing moments about the CG. Describe the change to yawing	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	moment caused by power changes. Describe the changes to yawing moment caused by engine distance from CG. Describe the methods to achieve balance.						
081 08 02 02	**Intentionally left blank**						
081 08 02 03	**Forces parallel to the lateral axis**						
LO	Explain: — the force on the vertical fin; — the fuselage side force due to sideslip; — the use of bank angle to tilt the lift vector. Explain how bank angle and sideslip are related in a steady asymmetric flight. Explain why the bank angle must be limited. Explain the effect on fin angle of attack due to sideslip.	x	x				
081 08 02 04	**Influence of aeroplane mass**						
LO	Explain why controllability with one engine inoperative is a typical problem encountered at low aeroplane mass.	x	x				
081 08 02 05	**Intentionally left blank**						
081 08 02 06	**Secondary propeller effects**						
LO	Describe propeller effects: — slip stream; — torque reaction; — asymmetric blade effect.	x	x				
081 08 02 07	**Intentionally left blank**						
081 08 02 08	**V_{MCA}**						
LO	Define 'V_{MCA}'.	x	x				

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
	Describe how V_{MCA} is determined. Explain the influence of the CG location.						
081 08 02 09	**V_{MCL}**						
LO	Define 'V_{MCL}'. Describe how V_{MCL} is determined. Explain the influence of the CG location.	x	x				
081 08 02 10	**V_{MCG}**						
LO	Define 'V_{MCG}'. Describe how V_{MCG} is determined. Explain the influence of the CG location.	x	x				
081 08 02 11	**Influence of density**						
LO	Describe the influence of density. Explain why V_{MCA}, V_{MCL} and V_{MCG} reduce with an increase in altitude and temperature.	x	x				
081 08 03 00	**Particular points on a polar curve**						
LO	Identify the particular points on a polar curve and explain their significance, assuming a parabolic approximation.	x	x				

N. SUBJECT 082 — PRINCIPLES OF FLIGHT (HELICOPTER)

(1) VOCABULARY OF MECHANICS

Speed is a scalar quantity, it has only magnitude.

Velocity is a vector quantity having magnitude and direction.

The velocity (speed) of a point of the aerofoil in the rotation around its axis is the 'linear' or 'tangential' velocity (speed).

The rotational velocity (speed) of a body around an axis is an angular velocity (speed) expressed in revolutions per minute (RPM), or degrees per second (deg/s), or radians per second (rad/s).

Density is the mass of the fluid per unit volume, in SI units kg/m^3.

(2) AERONAUTICAL DEFINITIONS

The blade is the aerofoil between a root radius and the tip radius (R) attached to the hub with hinges or flexible elements.

The cross section of a blade perpendicular to the feathering axis, the blade section at a distance (radius) from the hub centre shows the shape of the aerofoil.

Such section is characterised by a contour, a leading and trailing edge, a chord line, a chord, a camber line, the maximum thickness or depth, the thickness-to-chord ratio.

The blade element is a spanwise piece of the blade. It is assumed that its radial extension is small such that the aerodynamic forces don't vary with radial distance. The aerodynamic forces on the blade element produce lift, drag and a pitching moment.

The centre of pressure is defined as the point on the chord where the resultant of all aerodynamic forces acts such that the pitching moment about this point is zero.

The planform of the blade is the shape of the blade as seen from above.

The pitch angle of a section is the angle between the chord line and a reference plane. (The reference planes will be defined later in this text.)

The blade is without twist when the pitch angle is constant from root to tip.

The blade is twisted when the pitch angle of the sections varies as a function of the radial distance (the chord lines are not parallel). If the pitch angle decreases towards the tip, this is called washout.

The vector sum of the undisturbed upstream velocity and the thrust-induced velocity is the relative velocity.

In the helicopter theory we use the following definitions for 'angle of attack', 'lift' and 'drag':

— The angle between the relative velocity and the chord line is the angle of attack α or AoA, called effective angle of attack. The geometric angle of attack is the angle between the undisturbed upstream velocity and the chord line.
— Lift is the component of the aerodynamic force on a blade element perpendicular to the relative velocity.
— Profile drag is the component of the aerodynamic force on a blade element parallel to the relative velocity.

Profile drag is produced by the pressure forces and by skin-friction forces that act on the surface of the blade element.

The component of the drag force due to the pressure forces is the pressure or form drag.

The component of the drag due to the shear forces over the aerofoil is termed skin-friction drag.

The sum of the pressure drag and the skin-friction drag is the profile drag.

(3) HELICOPTER CHARACTERISTICS

Disc loading is by definition the mass M or weight W of the helicopter divided by the area of the disc.
(The disc area is πR^2, R being the blade-tip radius)

The disc loading is $M/(\pi R^2)$ or $W/(\pi R^2)$.

Blade loading is by definition the mass (weight) divided by the total planform area of the blades.

The area of a rectangular blade is given by chord times tip radius. For tapered blades, the mean geometric chord is taken as an approximately equivalent chord.

Blade loading is defined as the mass or weight of the helicopter divided by the total area of all blades.

Rotor solidity is the ratio of the total blade area to the disc area.

(4) PLANES, AXES, REFERENCE SYSTEMS OF THE ROTOR

— Shaft axis: the axis of the rotor shaft (mast).
— Hub plane: plane perpendicular to the shaft axis through the centre of the hub.
— Tip-path plane: the plane traced out by the blade tips. This plane is also the no-flapping plane.
— Virtual rotation axis: axis through the centre of the hub and perpendicular to the tip-path plane. Another name for this axis is no-flapping axis.
— Rotor-disc plane: another name for the tip-path plane.
— Rotor disc: the disc traced out by the blade tips in the tip-path plane.
— Plane of rotation: the plane parallel to the tip-path plane through the hub centre.
— No-feathering plane: is also called the control plane. This is the reference plane relative to which the pitch of the rotating blade has no variation during a full rotation. The control plane is parallel to the swash plate in the simple feathering mechanism (no flap-feathering coupling).
— Control axis or axis of no-feathering. Axis through the hub centre and perpendicular to the no-feathering or control plane.
— The azimuthal angle of the blade is the angle in the rotor-disc plane counted in the rotation sense from the direction opposite to the helicopter velocity.

(5) REFERENCE SYSTEMS (sometimes called frames of reference)

There are three different reference systems in which the movement of the blades can be studied or observed:

— The tip-path plane with the virtual rotation axis: the observer in this system observes no flapping, only cyclic feathering.
— The no-feathering plane (or control plane) with the control axis: the observer in this system observes no feathering, only cyclic flapping.
— The hub plane and shaft axis: the observer in this system observes both cyclic flapping and cyclic feathering.

(6) ANGLES OF THE BLADES, INDUCED VELOCITY

— Pitch angle of a blade section: the angle between the chord line of the section and the hub plane (the reference plane), also called local pitch angle.
— Pitch angle of the blade: the pitch angle at 75 % of the tip radius.
— Flapping angle: the angle between the longitudinal axis of the blade and the hub plane.
— Coning angle: the angle between the longitudinal axis of the blade and the tip-path plane.

— Advance angle: the azimuthal angle between the flapping axis and the point where the pitch link is connected to the swash plate (not to be confused with the phase lag from pitch input to flapping response).

The induced velocity is the velocity induced by the rotor thrust in the plane of the rotor disc (about 10 m/s for a light helicopter in hover). The slipstream velocity continues to increase downstream of the rotor. In the hover out-of-ground-effect (HOGE), the velocity in the ultimate wake is equal to two times the induced velocity.

Aerodynamic forces on the BLADES and the ROTOR.

The airflow around the blade element produces an aerodynamic force resolvable in two components: lift and drag. Lift is perpendicular to the relative air velocity, and drag is parallel to the relative air velocity.

The aerodynamic force may also be resolved into thrust perpendicular to the tip-path plane (or plane of rotation) and drag parallel to the tip-path plane. This drag is the sum of the profile drag and the induced drag.

Because the angle between the lift vector and the thrust vector is very small, the magnitudes of these two vectors may be taken as equal.

The blade thrust is the sum of the thrusts of all blade elements along the blade radius.

The sum of the thrusts of all blades is the (total) rotor thrust acting perpendicular to the tip-path plane in the direction of the virtual rotation axis.

The result of the induced drag forces on all the blade elements of all blades is a torque on the shaft which — multiplied by the angular velocity of the rotor — gives the required induced power.

The result of all the profile drags is a torque on the shaft which — multiplied by the angular velocity of the rotor — gives the required profile power.

(7) TYPES OF ROTOR HUBS

There are basically four types of rotor hubs in use:

1. Teetering rotor or seesaw rotor: The two blades are connected together; the hinge is on the shaft axis. A variation is the gimballed hub; the blades and the hub are attached to the rotor shaft by means of a gimbal or universal joint.
2. Fully articulated rotor: The rotor has more than two blades. Each blade has a flapping hinge, a lead-lag hinge and a feathering bearing.

3. Hingeless rotor: There are no flap and lead-lag hinges. They are replaced by flexible elements at the root of the blades which allow flapping and lead-lag movements. The feathering bearing allows feathering of the blade.
4. Bearingless rotor: There are no hinges or bearings. Flapping and lead or lag are obtained by flexing flexible elements called elastomeric hinges and feathering is obtained by twisting the element.

Two remarks:

1. Hinge offset and equivalent hinge offset
   The hinge offset is the distance between the shaft axis and the axis of the hinge. In the hingeless and bearingless rotor, we define an equivalent hinge offset.
2. Elastomeric hinges
   This bearing consists of alternate layers of elastomer and metal. The elasticity in the elastomer allows the movements of flapping, lead-lag and feathering.

(8) DRAG AND POWERS

The induced power is the power resulting from the induced velocity in the rotor disc for the generation of lift. For any given thrust, the induced power is minimum when the induced velocity is uniform over the rotor disc. Such velocity distribution can be approximated by using some blade twist (a truly uniform velocity cannot be obtained).

The rotor profile drag results from the component opposite to the blade velocities of all the profile drags of the blade elements of all the blades.

The resulting power is the rotor profile power or the profile-drag power (sum of the powers to overcome the torque).

The parasite drag is the drag on the helicopter fuselage including the drag of the rotor hub and all external equipment such as wheels, winch, etc. The tail-rotor drag is also included in the parasite drag. The power to overcome this drag is the parasite power.

In the level flight at constant speed, the main-rotor-induced power, the rotor profile power and the parasite power are summed to give the total power required to drive the main rotor.

The tail-rotor-induced power and the tail-rotor profile power are summed to give the power required to drive the tail rotor.

The power required to drive the auxiliary services, such as oil pumps and electrical generators, is the accessory or ancillary power. The power to overcome the mechanical friction in the transmissions is included in the accessory power.

The total power required in level flight at constant speed is the sum of the total power for the main rotor, the power for the tail rotor and the accessory power.

In the low-speed region, the required power in straight and level flight decreases as speed increases. The phenomenon is called translational lift.

The term limited power means that the total power required to hover OGE is greater than the available power.

(9) PHASE ANGLE IN FLAPPING MOVEMENT OF THE BLADE

The cyclic movement tilts the rotor disc in the direction of the intended helicopter velocity.

The flapping response is approximately 90° later than the applied cyclic pitch (somewhat less than 90° for hingeless rotors).

The pitch mechanism consists of the swash plate and for each blade a pitch link attached to the swash plate and a pitch horn attached to the blade.
(10) AXES THROUGH THE CENTRE OF THE HELICOPTER

Longitudinal axis or roll axis: Straight line through the centre of gravity of the helicopter from the nose to the tail about which the helicopter can roll left or right.

Lateral axis, transverse axis or pitch axis: Straight line through the centre of gravity of the helicopter about which the helicopter can pitch its nose up or down. (This axis is also perpendicular to the reference plane of the aircraft.)

Normal axis or yaw axis: Straight line perpendicular to the plane defined by the longitudinal and lateral axes and about which the helicopter can yaw.

Aircraft reference plane: The plane with respect to which a subset of the components that constitutes the major part of the aircraft is symmetrically disposed in the port and starboard sense.

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
080 00 00 00	**PRINCIPLES OF FLIGHT**						
082 00 00 00	**PRINCIPLES OF FLIGHT — HELICOPTER**						
082 01 00 00	**SUBSONIC AERODYNAMICS**						
082 01 01 00	**Basic concepts, laws and definitions**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
082 01 01 01	**SI units and conversion of units**						
LO	List the fundamental quantities and units in SI system: mass (kg), length (m), time (s).			x	x	x	
LO	Show and apply tables of conversion of units of English units to SI units and vice versa.			x	x	x	
LO	The units of the physical quantities should be mentioned when they are introduced.			x	x	x	
082 01 01 02	**Definitions and basic concepts about air**						
LO	Describe air temperature and pressure as functions of height.			x	x	x	
LO	Use the table of the International Standard Atmosphere.			x	x	x	
LO	Define air density; explain the relationship between density, pressure and temperature.			x	x	x	
LO	Explain the influence of moisture content on density.			x	x	x	
LO	Define pressure altitude and density altitude.			x	x	x	
082 01 01 03	**Newton's laws**						
LO	Describe Newton's second law: force equals product of mass and acceleration.			x	x	x	
LO	Distinguish mass and weight, units.			x	x	x	
LO	Describe the other form of the second law, applicable to thrust.			x	x	x	
LO	Describe Newton's third law: action and reaction, force and torque.			x	x	x	
082 01 01 04	**Basic concepts of airflow**						
LO	Describe steady and unsteady airflow.			x	x	x	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Define 'streamline' and 'stream tube'.			x	x	x	
LO	Equation of continuity or mass conservation.			x	x	x	
LO	Mass-flow rate through a stream-tube section.			x	x	x	
LO	Describe the relation between the external force on a stream tube and the momentum variation of the airflow.			x	x	x	
LO	State the Bernoulli's equation in a non-viscous airflow, use this equation to explain and define static pressure, dynamic pressure and total pressure.			x	x	x	
LO	Define the stagnation point in a flow around an aerofoil and explain the pressure obtained in the stagnation point.			x	x	x	
LO	Describe the pitot system and explain the measurement of airspeed (no compressibility effects).			x	x	x	
LO	Define TAS, IAS, CAS.			x	x	x	
LO	Define a two-dimensional airflow and an aerofoil of infinite span. Explain the difference between a two-dimensional and a three-dimensional airflow.			x	x	x	
LO	Explain that viscosity is a feature of a fluid (gas or liquid).			x	x	x	
LO	Describe the airflow over a flat surface and explain the tangential friction between air and surface and the development of a boundary layer.			x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Define a laminar boundary layer, a turbulent boundary layer and the transition from laminar to turbulent. Show the influence of the roughness of the surface on the position of the transition point.			x	x	x	
082 01 02 00	**Two-dimensional airflow**						
082 01 02 01	**Aerofoil section geometry**						
LO	Define the terms 'aerofoil section', 'aerofoil element', 'chord line', 'chord', 'thickness', 'thickness-to-chord ratio of section', 'camber line', 'camber', 'leading-edge radius'.			x	x	x	
LO	Describe different aerofoil sections, symmetrical and asymmetrical.			x	x	x	
082 01 02 02	**Aerodynamic forces on aerofoil elements**						
LO	Define the 'angle of attack'.			x	x	x	
LO	Describe the pressure distribution on the upper and lower surface.			x	x	x	
LO	Describe the boundary layers on the upper and lower surfaces for small angles of attack (below the onset of stall).			x	x	x	
LO	Describe the resultant force due to the pressure distribution and the friction at the element, the boundary layers and the velocities in the wake, the loss of momentum due to friction forces.			x	x	x	
LO	Resolve the aerodynamic force into the components lift and drag.			x	x	x	
LO	Define the lift coefficient and the drag coefficient, equations.			x	x	x	
LO	Show that the lift coefficient is a function of the angle of attack, draw the graph.			x	x	x	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain how drag is caused by pressure forces on the surfaces and by friction forces in the boundary layers. Define the term 'profile drag'.			x	x	x	
LO	Draw the graph of lift (or of the lift coefficient) as a function of drag or of the drag coefficient and define the lift–drag ratio.			x	x	x	
LO	Use the equations of lift and drag to show the influence of speed and density on lift and drag for a given angle of attack and to calculate lift and drag.			x	x	x	
LO	Define the action line of the aerodynamic force, the centre of pressure, the pitching moment.			x	x	x	
LO	Know that the pitching moment about the centre of pressure is zero by definition.			x	x	x	
LO	Know that symmetrical aerofoils have the centre of pressure a quarter chord behind the leading edge independently of the angle of attack as long as the angle of attack remains smaller than the angle of stall.			x	x	x	
LO	Taking an asymmetrical aerofoil section with different cambers, know the position of the centre of pressure, the influence of the angle of attack on the centre of pressure and the pitching moment about a line which is a quarter chord behind the leading edge.			x	x	x	
082 01 02 03	**Stall**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain the boundary layer separation when the angle of attack increases beyond stall onset and the decrease of lift and the increase of drag. Define the 'separation point and line'.			x	x	x	
LO	Draw a graph of lift and drag coefficient as a function of the angle of attack before and beyond the stall onset.			x	x	x	
LO	Describe how the stall phenomenon displaces the centre of pressure and how pitching moments appear about the line at quarter chord behind the leading edge.			x	x	x	
082 01 02 04	**Disturbances due to profile contamination**						
LO	Explain ice contamination, the modification of the section profile and the surfaces due to ice and snow, influence on lift and drag and L–D ratio, on the angle of attack at stall onset, effect of the weight increase.			x	x	x	
LO	Explain the erosion effect of heavy rain on the wing and subsequent increase of profile drag.			x	x	x	
082 01 03 00	**Three-dimensional airflow around a blade (wing) and a fuselage**						
082 01 03 01	**The blade**						
LO	Describe different planforms of blades, and describe untwisted and twisted blades.			x	x	x	
LO	Define the root chord and the tip chord, the mean chord, the aspect ratio and the blade twist.			x	x	x	
082 01 03 02	**Airflow pattern and influence on lift**						

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain the spanwise flow in the case of a blade and the appearance of the tip vortices which are a loss of energy.			x	x	x	
LO	Show that the strength of the vortices increases as the angle of attack and the lift increase.			x	x	x	
LO	Show that downwash causes vortices.			x	x	x	
LO	Define the effective air velocity as the resultant of the undisturbed air velocity and the induced velocity and define the effective angle of attack.			x	x	x	
LO	Explain the spanwise lift distribution and how it can be modified by twist.			x	x	x	
082 01 03 03	**Induced drag**						
LO	Explain the thrust-induced drag, the influence of the angle of attack and of the aspect ratio.			x	x	x	
082 01 03 04	**The airflow around a fuselage**						
LO	Describe the aircraft fuselage and the external components which cause drag, the airflow around the fuselage, influence of the pitch angle of the fuselage.			x	x	x	
LO	Define parasite drag as the sum of pressure drag and friction drag.			x	x	x	
LO	Define ‘interference drag’.			x	x	x	
LO	Describe fuselage shapes that minimise drag.			x	x	x	
LO	Know the formula of the parasite drag and explain the influence of the speed.			x	x	x	
082 02 00 00	**TRANSONIC AERODYNAMICS AND COMPRESSIBILITY EFFECTS**						
082 02 01 00	**Airflow speeds and velocities**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
082 02 01 01	**Speeds and Mach number**						
LO	Define the speed of sound in air.			x	x	x	
LO	State that the speed of sound is proportional to the square root of the absolute temperature (unit Kelvin).			x	x	x	
LO	Explain the variation of speed of sound with altitude.			x	x	x	
LO	Define Mach number.			x	x	x	
LO	Explain the meaning of incompressibility and compressibility of air; relate this to the value of Mach number.			x	x	x	
LO	Define subsonic, high subsonic and supersonic flows in relation to the value of the Mach number.			x	x	x	
082 02 01 02	**Shock waves**						
LO	Describe a shock wave in a supersonic flow and the pressure and speed changes by the shock.			x	x	x	
LO	Describe the appearance of local supersonic flows at the upper surface of a blade section and the compression by a shock when the section is in an upstream high subsonic flow.			x	x	x	
LO	Describe the effect of the shock on lift, drag, the pitching moment and the C_L–C_D ratio, drag divergence Mach number.			x	x	x	
082 02 01 03	**Influence of aerofoil section and blade planform**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain the different shapes which allow higher upstream Mach numbers without generating a shock wave on the upper surface: — reducing the section thickness-to-chord ratio; — special aerofoil sections as supercritical shapes; — a planform with sweep angle, positive and negative.			x	x	x	
082 03 00 00	**ROTORCRAFT TYPES**						
082 03 01 00	**Rotorcraft**						
082 03 01 01	**Rotorcraft types**						
LO	Define the 'autogyro' and the 'helicopter'.			x	x	x	
LO	Explain the rolling moment on an autogyro with fixed blades, the necessity to use flapping hinges and the ensuing reduction of the moment arm, the flapback of the blades.			x	x	x	
082 03 02 00	**Helicopters**						
082 03 02 01	**Helicopter configurations**						
LO	Describe the single main rotor helicopter and the other configurations: tandem, coaxial, side by side, synchrocopter (intermeshing blades), the compound helicopter, tilt-wing and tilt-rotor.			x	x	x	
082 03 02 02	**The helicopter, characteristics and associated terminology**						
LO	Describe the general layout of a single main rotor helicopter, fuselage, engine or engines, main gearbox, main rotor shaft and rotor hub.			x	x	x	
LO	Mention the tail rotor at the aft of the fuselage, the fenestron and the NOTOR (No Tail Rotor).			x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Define the rotor disc area and the blade area, the blades turning in the hubplane.			x	x	x	
LO	Describe the teetering rotor with the hinge axis on the shaft axis and the rotor with more than two blades with offset hinge axes.			x	x	x	
LO	Define the fuselage centre line and the three axes: roll, pitch and normal.			x	x	x	
LO	Define the gross weight and the gross mass (units), the disc and blade loading.			x	x	x	
082 04 00 00	**MAIN-ROTOR AERODYNAMICS**						
082 04 01 00	**Hover flight Outside Ground Effect (OGE)**						
082 04 01 01	**Airflow through the rotor disc and around the blades**						
LO	Define the circumferential (tangential) velocity of the blade sections, which equals the angular velocity of the rotor multiplied by the radius of the section.			x	x	x	
LO	Keep the blade fixed and define the undisturbed upstream air velocity relative to the blade.			x	x	x	
LO	Based on Newton’s second law (momentum), explain that the vertical force on the disc, the rotor thrust, produces vertical downward velocities in the rotor-disc plane. The values of these thrust-induced velocities increase as the thrust increases and decrease with increasing rotor diameter. Know that the velocities some distance downstream are twice the value of the induced speed in the disc plane.			x	x	x	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain why the production of the induced flow requires a power on the shaft, the induced power. The induced power is smallest if the induced velocities have the same value on the whole disc (flow uniformity over the disc).			x	x	x	
LO	Describe uniform and typical non-uniform velocities through the rotor disc.			x	x	x	
LO	Explain why the vertical rotor thrust must be somewhat higher than the weight because of the vertical drag on the fuselage.			x	x	x	
LO	Describe the vertical air velocities relative to the rotor disc as the sum of the upstream air velocities and the induced velocities.			x	x	x	
LO	Define the pitch angle and the angle of attack of a blade element.			x	x	x	
LO	Explain lift and the profile drag of a blade element.			x	x	x	
LO	Explain the resulting lift and the thrust on the blade, define the resulting rotor thrust.			x	x	x	
LO	Explain the necessity of collective pitch angle changes, the influence on the angles of attack and on the rotor thrust and the necessity of blade feathering.			x	x	x	
LO	Explain the blade twist necessary to obtain a more even induced airspeed over the disc.			x	x	x	
LO	Describe the different blade shapes (as viewed from above).			x	x	x	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain how the profile drag on the blade elements generates a torque on the main shaft and define the resulting rotor profile power.			x	x	x	
LO	Explain the influence of air density on the required powers.			x	x	x	
LO	Show the effect on the airflow over the blade tips.			x	x	x	
082 04 01 02	**Anti-torque force and tail rotor**						
LO	Based on Newton's third law, explain the need of a tail-rotor thrust, the required value being proportional to the main-rotor torque. Show that the tail-rotor power is proportional to the tail-rotor thrust.			x	x	x	
LO	Explain the necessity of blade feathering of the tail-rotor blades and the control by the yaw pedals, the maximum and minimum values of the pitch angles of the blades.			x	x	x	
082 04 01 03	**Total power required and hover altitude Outside Ground Effect (OGE)**						
LO	Define the ancillary equipment and its power requirement.			x	x	x	
LO	Define the total power required.			x	x	x	
LO	Describe the influence of ambient pressure, temperature and moisture on the required power.			x	x	x	
082 04 02 00	**Vertical climb**						
082 04 02 01	**Relative airflow and angles of attack**						
LO	Describe the climb speed and the opposite vertical air velocity relative to the rotor disk.			x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain the relative air velocities and the angle of attack of the blade elements.			x	x	x	
LO	Explain how the angle of attack is controlled by the collective pitch angle control.			x	x	x	
082 04 02 02	**Power and vertical speed**						
LO	Define the total main-rotor power as the sum of the parasite power, the induced power, the climb power and the rotor profile power.			x	x	x	
LO	Explain why the total main-rotor power increases when the rate of climb increases.			x	x	x	
LO	Define the total required power in vertical flight.			x	x	x	
082 04 03 00	**Forward flight**						
082 04 03 01	**Airflow and forces in uniform inflow distribution**						
LO	Explain the assumption of a uniform inflow distribution on the rotor disc.			x	x	x	
LO	Define the azimuth angle of a blade, the advancing blade angular range centred at 90°, and the retreating blade range centred at 270°.			x	x	x	
LO	Show the upstream air velocities relative to the blade elements and the different effects on the advancing and retreating blade. Define the area of reverse flow. Explain the influence of forward speed on the tip circumferential speed.			x	x	x	
LO	Assuming constant pitch angles and rigid blade attachments, explain the huge roll moment by the asymmetric lift distribution.			x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Show that through cyclic feathering this imbalance could be eliminated by a low angle of attack (accomplished by a low-pitch angle) on the advancing blade and a high angle of attack (accomplished by a high-pitch angle) on the retreating blade.			x	x	x	
LO	Describe the high air velocity at the advancing blade tip and the compressibility effects which limit the maximum speed of the helicopter.			x	x	x	
LO	Describe the low air velocities on the retreating blade tip resulting from the circumferential speed and the forward speed, the necessity of high angle of attack and the onset of stall.			x	x	x	
LO	Define the tip–speed ratio and show the limits.			x	x	x	
LO	Explain the rotor thrust perpendicular to the rotor disc and the necessity to tilt the thrust vector forward. (Realisation will be explained in 082 05 00 00)			x	x	x	
LO	Explain the equilibrium conditions in steady straight and level flight.			x	x	x	
082 04 03 02	**The flare (powered flight)**						
LO	Explain the flare in powered flight, the rearward tilt of the rotor disc and of the thrust vector. Show the horizontal thrust component opposite to the speed.			x	x	x	
LO	State the increase of the thrust due to the upward inflow, and show the modifications of the angles of attack.			x	x	x	
LO	Explain the increase of rotor RPM in the case of a non-governed rotor.			x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain the actions to be taken by the pilot.			x	x	x	
082 04 03 03	**Non-uniform inflow distribution in relation to inflow roll**						
LO	Explain why the uniform inflow distribution is an assumption to simplify the theory and describe the real inflow distribution which modifies the angle of attack and the lift especially on the forward and backward blades.			x	x	x	
082 04 03 04	**Power and maximum speed**						
LO	Explain that the induced velocities and induced power decrease as the helicopter speed increases.			x	x	x	
LO	Define the profile drag and the profile power and their increase with helicopter speed.			x	x	x	
LO	Define the fuselage drag and the parasite power and the increase with helicopter speed.			x	x	x	
LO	Define the total drag and the increase with helicopter speed.			x	x	x	
LO	Describe the tail-rotor power and the power required by the ancillary equipment.			x	x	x	
LO	Define the total power requirement as a sum of the partial powers and explain how this total power varies with helicopter speed.			x	x	x	
LO	Explain the influence of the helicopter mass, the air density and additional external equipment on the partial powers and the total power required.			x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Describe the translational lift and show the decrease of required total power as the helicopter speed increases in the low-speed region.			x	x	x	
082 04 04 00	**Hover and forward flight In Ground Effect (IGE)**						
082 04 04 01	**Airflow in ground effect, downwash**						
LO	Explain how the vicinity of the ground changes the downward flow pattern and the consequences on lift (thrust) at constant rotor power. Show that the ground effect depends on the height of the rotor above the ground and the rotor diameter. Show the required rotor power at constant AUM as a function of height above the ground. Describe the influence of the forward speed.			x	x	x	
082 04 05 00	**Vertical descent**						
082 04 05 01	**Vertical descent, power on**						
LO	Describe the airflow to the rotor disc in a trouble-free vertical descent, power on, the airflow opposite to the helicopter velocity, the relative air velocity and the angle of attack.			x	x	x	
LO	Explain the vortex-ring state, the settling with power. State the approximate values of vertical descent speeds for the formation of vortex ring related to the values of the induced velocities.			x	x	x	
LO	Describe the airflow relative to the blades, the root stall, the loss of lift on the blade tip, the turbulence. Show the effect of raising the lever and discuss the effects on the controls.			x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
082 04 05 02	**Autorotation**						
LO	State the need for early recognition of malfunctions and for a quick initiation of recovery. Describe the recovery actions.			x	x	x	
LO	Explain that the collective lever position must be lowered sufficient quickly to avoid a rapid decay of rotor RPM, explain the influence of the rotational inertia of the rotor on the rate of decay.			x	x	x	
LO	Show the induced flow through the rotor disc, the rotational velocity and the relative airflow, the inflow and inflow angles.			x	x	x	
LO	Show how the aerodynamic forces on the blade elements vary from root to tip and distinguish three zones: the inner stalled ring (stall region), the middle autorotation ring (driving region), and the outer anti-autorotation ring (driven region). Explain the RPM stability at a given collective pitch.			x	x	x	
LO	Explain the control of the rotor RPM with collective pitch.			x	x	x	
LO	Show the need of negative tail-rotor thrust for yaw control.			x	x	x	
LO	Explain the final increase in rotor thrust by pulling the collective to decrease the vertical descent speed and the decay in rotor RPM.			x	x	x	
082 04 06 00	**Forward flight — Autorotation**						
082 04 06 01	**Airflow at the rotor disc**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain the factors affecting inflow angle and angle of attack, the autorotative power distribution and the asymmetry over the rotor disc in forward flight.			x	x	x	
082 04 06 02	**Flight and landing**						
LO	Show the effect of forward speed on the vertical descent speed.			x	x	x	
LO	Explain the effects of gross weight, rotor RPM and altitude (density) on endurance and range.			x	x	x	
LO	Explain the manoeuvers of turning and touchdown.			x	x	x	
LO	Explain the height–velocity avoidance graph or dead man's curves.			x	x	x	
082 05 00 00	**MAIN-ROTOR MECHANICS**						
082 05 01 00	**Flapping of the blade in hover**						
082 05 01 01	**Forces and stresses on the blade**						
LO	Show how the centrifugal forces depend on rotor RPM and blade mass and how they pull on the blade attachment to the hub. Apply the formula to an example. Justify the upper limit of the rotor RPM.			x	x	x	
LO	Assume a rigid attachment and show how thrust may cause huge oscillating bending moments which stress the attachment.			x	x	x	
LO	Explain why flapping hinges do not transfer such moments. Show the small flapping hinge offset on fully articulated rotors and zero offset in the case of teetering rotors.			x	x	x	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Describe the working principle of the flexible element in the hingeless rotor and describe the equivalent flapping hinge offset compared to that of the articulated rotor.			x	x	x	
082 05 01 02	**Centrifugal turning moment**						
LO	Describe the centrifugal forces on the mass elements of a blade with pitch applied and the components of these forces. Show how these forces generate a moment which tries to reduce the blade-pitch angle.			x	x	x	
LO	Explain the methods of counteracting by hydraulics, bias springs and balance masses.			x	x	x	
082 05 01 03	**Coning angle in hover**						
LO	Show how the equilibrium of the moments about the flapping hinge of lift (thrust) and of the centrifugal force determine the coning angle of the blade (the blade weight being negligible).			x	x	x	
LO	Define the tip-path plane and the coning angle.			x	x	x	
LO	Explain the influence of rotor RPM and lift on the coning angle, justify the lower limit of the rotor RPM, relate the lift on one blade to the gross weight.			x	x	x	
LO	Explain the effect of the mass of the blade on the tip path and the tracking.			x	x	x	
082 05 02 00	**Flapping angles of the blade in forward flight**						
082 05 02 01	**Forces on the blade in forward flight without cyclic feathering**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Assume rigid attachments of the blade to the hub and show the periodic lift, moment and stresses on the attachment, the ensuing metal fatigue, the roll moment on the helicopter and justify the necessity for flapping hinge.			x	x	x	
LO	Assume no cyclic pitch and describe the lift on the advancing and the retreating blades.			x	x	x	
LO	State the azimuthal phase lag (90° or less) between the input (applied pitch) and the output (flapping angle). Explain the rotor flapback (the rearward tilting of the tip-path plane and the rotor thrust).			x	x	x	
082 05 02 02	**Cyclic pitch (feathering) in helicopter mode, forward flight**						
LO	Show that in order to assume and maintain forward flight, the rotor-thrust vector must get a forward component by tilting the tip-path plane.			x	x	x	
LO	Show how the applied cyclic pitch modifies the lift on the advancing and retreating blades and produces the required forward tilting of the tip-path plane and the rotor thrust.			x	x	x	
LO	Show the cone described by the blades and define the virtual axis of rotation (or the no flapping axis). Define the plane of rotation.			x	x	x	
LO	Define the reference system in which we define the movements: the shaft axis and the hub plane.			x	x	x	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Describe the swash plates, the pitch link and the pitch horn. Explain how the collective lever moves the non-rotating swash plate up or down alongside the shaft axis.			x	x	x	
LO	Describe the mechanism by which the desired cyclic blade pitch can be produced by tilting the swash plate with the cyclic stick.			x	x	x	
LO	Define the no-feathering or control plane (control orbit) and the no-feathering axis or control axis.			x	x	x	
LO	Explain the translational lift effect when the speed increases.			x	x	x	
LO	Justify the increase of the tilt angle of the thrust vector and of the tip-path plane disc in order to increase the speed.			x	x	x	
082 05 03 00	**Blade-lag motion in forward flight**						
082 05 03 01	**Forces on the blade in the disc plane (tip-path plane) in forward flight**						
LO	Explain the Coriolis force due to flapping, the resulting periodic moments in the hub plane and the resulting periodic stresses which make lead-lag hinges necessary to avoid material fatigue.			x	x	x	
LO	Describe the profile-drag forces on the blade elements and the periodic variation of these forces.			x	x	x	
082 05 03 02	**The drag or lag hinge**						
LO	Describe the drag hinge of the fully articulated rotor and the lag flexure in the hingeless rotor.			x	x	x	
LO	Explain the necessity for drag dampers.			x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
082 05 03 03	**Ground resonance**						
LO	Explain the movement of the centre of gravity of the blades due to the lead-lag movements in the multiblade rotor.			x	x	x	
LO	Show the effect on the fuselage and the danger of resonance between this force and the fuselage and undercarriage. State the conditions likely to lead to ground resonance.			x	x	x	
082 05 04 00	**Rotor systems**						
082 05 04 01	**See-saw or teetering rotor**						
LO	Explain that a teetering rotor is prone to mast bumping in low G situations because of having no flapping hinge offset.			x	x	x	
082 05 04 02	**Fully articulated rotor**						
LO	Describe the fully articulated rotor with hinges and feathering bearings.			x	x	x	
LO	Describe ball and roller bearings and elastomeric bearings, advantages and disadvantages.			x	x	x	
082 05 04 03	**Hingeless rotor, bearingless rotor**						
LO	Show the forces on the flapping hinges with large offset (virtual hinge) and the resulting moments, compare them with other rotor systems.			x	x	x	
082 05 05 00	**Blade sailing**						
082 05 05 01	**Blade sailing and causes**						
LO	Define blade sailing, the influence of low rotor RPM and of headwind.			x	x	x	
082 05 05 02	**Minimising the danger**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Describe the actions to minimise danger and the demonstrated wind envelope for engaging and disengaging rotors.			x	x	x	
082 05 05 03	**Droop stops**						
LO	Explain the utility of the droop stops, retraction of the stops.			x	x	x	
082 05 06 00	**Vibrations due to main rotor**						
082 05 06 01	**Origins of the vertical vibrations**						
LO	Explain the lift (thrust) variations per revolution of a blade and the resulting vertical rotor-thrust variation in the case of perfect identical blades.			x	x	x	
LO	Show the resulting frequencies and amplitudes as a function of the number of blades.			x	x	x	
LO	Explain the thrust variation in case of an out-of-track blade, causes, frequencies (one-per-revolution).			x	x	x	
LO	Explain the importance of the hinges offset on the effect of the vibrations on the fuselage.			x	x	x	
082 05 06 02	**Lateral vibrations**						
LO	Explain imbalances of a blade, causes, and effects.			x	x	x	
LO	Explain the frequencies lateral one-per-revolution vibration.			x	x	x	
082 06 00 00	**TAIL ROTORS**						
082 06 01 00	**Conventional tail rotor**						
082 06 01 01	**Tail rotor description**						
LO	Describe the two-bladed rotor with teetering hinge, the rotors with more than two blades.			x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Show the flapping hinges and the feathering bearing.			x	x	x	
LO	Describe the dangers to ground personnel, to the rotor blades, possibilities of minimising these dangers.			x	x	x	
082 06 01 02	**Tail-rotor aerodynamics**						
LO	Explain the airflow around the blades in hover and in forward flight, the effects of the tip speeds on the noise production and the compressibility, limits.			x	x	x	
LO	Explain in hovering the effect of wind on the tail-rotor aerodynamics and thrust, problems.			x	x	x	
LO	Explain the tail-rotor thrust and the control through pitch control (feathering).			x	x	x	
LO	Explain the tail-rotor flapback, and the effects of delta-three hinges.			x	x	x	
LO	Describe roll moment and drift as side effects of the tail rotor.			x	x	x	
LO	Explain the effects of the tail-rotor failure.			x	x	x	
LO	Explain the loss of tail-rotor effectiveness, vortex-ring state, causes, crosswind and yaw speed.			x	x	x	
082 06 01 03	**Strakes on the tail boom**						
LO	Describe the strake and explain the function of the device.			x	x	x	
082 06 02 00	**The fenestron**						
082 06 02 01	**Technical layout**						
LO	Show the technical layout of a fenestron tail rotor.			x	x	x	
082 06 02 02	**Control concepts**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain the control concepts of a fenestron tail rotor.			x	x	x	
082 06 02 03	**Advantages and disadvantages**						
LO	Explain the advantages and disadvantages.			x	x	x	
082 06 03 00	**The NOTAR**						
082 06 03 01	**Technical layout**						
LO	Show the technical layout.			x	x	x	
082 06 03 02	**Control concepts**						
LO	Explain the control concepts.			x	x	x	
082 06 03 03	**Advantages and disadvantages**						
LO	Explain the advantages and disadvantages.			x	x	x	
082 06 04 00	**Vibrations**						
082 06 04 01	**Tail-rotor vibrations**						
LO	Explain the sources of vibration of the tail rotor and the resulting high frequencies.			x	x	x	
082 06 04 02	**Balancing and tracking**						
LO	Explain balancing and tracking of the tail rotor.			x	x	x	
082 07 00 00	**EQUILIBRIUM, STABILITY AND CONTROL**						
082 07 01 00	**Equilibrium and helicopter attitudes**						
082 07 01 01	**Hover**						
LO	Explain why the vector sum of forces and moments must be zero in any acceleration-free situation.			x	x	x	
LO	Indicate the forces and the moments about the lateral axis in a steady hover.			x	x	x	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Indicate the forces and the moments about the longitudinal axis in a steady hover.			x	x	x	
LO	Deduce how the roll angle in a steady hover without wind results from the moments about the longitudinal axis.			x	x	x	
LO	Explain how the cyclic is used to create equilibrium of moments about the lateral axis in a steady hover.			x	x	x	
LO	Explain the consequence of the cyclic stick reaching its forward or aft limit during an attempt to take off to the hover.			x	x	x	
LO	Explain the influence of the density altitude on the equilibrium of forces and moments in a steady hover.			x	x	x	
082 07 01 02	**Forward flight**						
LO	Explain why the vector sum of forces and of moments must be zero in unaccelerated flight.			x	x	x	
LO	Indicate the forces and the moments about the lateral axis acting on a helicopter in a steady straight and level flight.			x	x	x	
LO	Explain the influence of All-Up Mass (AUM) on the forces and moments about the lateral axis in forward flight.			x	x	x	
LO	Explain the influence of the position of the centre of gravity on the forces and moments about the lateral axis in forward flight.			x	x	x	
LO	Explain the role of the cyclic stick position in creating equilibrium of forces and moments about the lateral axis in forward flight.			x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain how forward speed influences the fuselage attitude.			x	x	x	
LO	Describe and explain the inflow roll effect.			x	x	x	
082 07 02 00	**Stability**						
082 07 02 01	**Static longitudinal, roll and directional stability**						
LO	Define static stability; give an example of static stability and of static instability.			x	x	x	
LO	Explain the contribution of the main rotor to speed stability.			x	x	x	
LO	Describe the influence of the horizontal stabiliser on static longitudinal stability.			x	x	x	
LO	Explain the effect of hinge offset on static stability.			x	x	x	
LO	Describe the influence of the tail rotor on static directional stability.			x	x	x	
LO	Describe the influence of the vertical stabiliser on static directional stability.			x	x	x	
LO	Explain the influence of the main rotor on the static roll stability.			x	x	x	
LO	Describe the influence of the longitudinal position of the centre of gravity on the static longitudinal stability.			x	x	x	
082 07 02 02	**Static stability in the hover**						
LO	Describe the initial movements of a hovering helicopter after the occurrence of a horizontal gust.			x	x	x	
082 07 02 03	**Dynamic stability**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Define dynamic stability; give an example of dynamic stability and of dynamic instability.			x	x	x	
LO	Explain why static stability is a precondition for dynamic stability.			x	x	x	
082 07 02 04	**Longitudinal stability**						
LO	Explain the individual contributions of angle of attack and speed stability together with the stabiliser and fuselage on the dynamic longitudinal stability.			x	x	x	
LO	Explain the principle of stability-augmentation systems.			x	x	x	
LO	Define the characteristics of a phugoid.			x	x	x	
082 07 02 05	**Roll stability and directional stability**						
LO	Explain the effect of a dihedral on a helicopter.			x	x	x	
LO	Describe how a dihedral influences the static roll stability.			x	x	x	
LO	Know that a large static roll stability together with a small directional stability may lead to a Dutch roll.			x	x	x	
LO	Explain which stability features taken together may result in spiral dive and the reason why.			x	x	x	
LO	Explain the static directional stability features of a tandem rotor type helicopter.			x	x	x	
082 07 03 00	**Control**						
082 07 03 01	**Manoeuver stability**						
LO	Define the meaning of stick-force stability.			x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Define the meaning of stick-position stability.			x	x	x	
LO	Explain the meaning of the stick-force diagram and trim speed.			x	x	x	
LO	Explain the meaning of stick force per G.			x	x	x	
LO	Explain how a bob weight influences stick force per G.			x	x	x	
LO	Explain how helicopter control can be limited because of available stick travel.			x	x	x	
LO	Explain how the position of the centre of gravity influences the remaining stick travel.			x	x	x	
082 07 03 02	**Control power**						
LO	Explain the meaning of the control moment.			x	x	x	
LO	Explain the importance of the centre of gravity position on the control moment.			x	x	x	
LO	Explain how the changes of magnitude of rotor thrust of a helicopter during manoeuvres influence the control moment.			x	x	x	
LO	Explain which control moment provides control for a helicopter rotor with zero-hinge offset (central flapping hinge).			x	x	x	
LO	Explain the different type of rotor control moments which together provide the control of helicopters with a hingeless or a fully articulated rotor system.			x	x	x	
LO	Explain the influence of hinge offset on controllability.			x	x	x	
082 07 03 03	**Static and dynamic rollover**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain the mechanism which causes dynamic rollover.			x	x	x	
LO	Explain the required pilot action when dynamic rollover is starting to develop.			x	x	x	
082 08 00 00	**HELICOPTER FLIGHT MECHANICS**						
082 08 01 00	**Flight limits**						
082 08 01 01	**Hover and vertical flight**						
LO	Show the power required OGE and IGE and the power available, the OGE and IGE maximum hover height (see subject 020, piston engines and turbine engines).			x	x	x	
LO	Explain the effects of All-Up Mass (AUM), ambient temperature and pressure, density altitude and moisture.			x	x	x	
LO	Discuss the rate of climb in a vertical flight.			x	x	x	
082 08 01 02	**Forward flight**						
LO	Compare the power required and the power available as a function of speed in straight and level flight.			x	x	x	
LO	Define the maximum speed limited by power and the value relative to V_{NE} and V_{NO}.			x	x	x	
LO	Use the graph to determine the speeds of maximum rate of climb and the maximum angle of climb.			x	x	x	
LO	Use the graph to define the TAS for maximum range and maximum endurance, consider the case of the piston engine and the turbine engine. Explain the effects of tailwind or headwind on the speed for maximum range.			x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL /IR	ATPL	CPL	
LO	Explain the effects of AUM, pressure and temperature, density altitude, humidity.			x	x	x	
082 08 01 03	**Manoeuvring**						
LO	Define the load factor, the radius of turn and the rate of turn.			x	x	x	
LO	Explain the relationship between the bank angle, the airspeed and the radius of turn, between the bank angle and the load factor.			x	x	x	
LO	Explain the influence of All-Up Mass (AUM), pressure and temperature, density altitude, humidity.			x	x	x	
LO	Define the limit-load factors and the certification categories.			x	x	x	
082 08 02 00	**Special conditions**						
082 08 02 01	**Operating with limited power**						
LO	Explain the operations with limited power, use the graph to show the limitations on vertical flight and level flight, discuss the power checks and procedures for take-off and landing.			x	x	x	
LO	Describe manoeuvres with limited power.			x	x	x	
082 08 02 02	**Overpitch, overtorque**						
LO	Describe overpitching and show the consequences.			x	x	x	
LO	Describe situations likely to lead to overpitching.			x	x	x	
LO	Describe overtorqueing and show the consequences.			x	x	x	
LO	Describe situations likely to lead to overtorqueing.			x	x	x	

O. SUBJECT 091 — VFR COMMUNICATIONS

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
090 00 00 00	**COMMUNICATIONS**						
091 00 00 00	**VFR COMMUNICATIONS**						
091 01 00 00	**DEFINITIONS**						
091 01 01 00	**Meanings and significance of associated terms**						
LO	Stations.	x	x	x	x	x	
LO	Communication methods.	x	x	x	x	x	
091 01 02 00	**Air Traffic Services abbreviations**						
LO	Define commonly used Air Traffic Control abbreviations: — flight conditions; — airspace; — services; — time; — miscellaneous.	x	x	x	x	x	
091 01 03 00	**Q-code groups commonly used in RTF air–ground communications**						
LO	Define Q-code groups commonly used in RTF air-to-ground communications: — pressure settings; — directions and bearings.	x	x	x	x	x	
LO	State the procedure for obtaining bearing information in flight.	x	x	x	x	x	
091 01 04 00	**Categories of messages**						
LO	List the categories of messages in order of priority.	x	x	x	x	x	
LO	Identify the types of messages appropriate to each category.	x	x	x	x	x	
LO	List the priority of a message (from given examples of messages to compare).	x	x	x	x	x	
091 02 00 00	**GENERAL OPERATING PROCEDURES**						
091 02 01 00	**Transmission of letters**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	State the phonetic alphabet used in radio-telephony.	x	x	x	x	x	
LO	Identify the occasions when words should be spelt.	x	x	x	x	x	
091 02 02 00	**Transmission of numbers (including level information)**						
LO	Describe the method of transmission of numbers: — pronunciation; — single digits, whole hundreds and whole thousands.	x	x	x	x	x	
091 02 03 00	**Transmission of time**						
LO	Describe the ways of transmitting time: — standard time reference (UTC); — Minutes, minutes and hours, when required.	x	x	x	x	x	
091 02 04 00	**Transmission technique**						
LO	Explain the techniques used for making good R/T transmissions.	x	x	x	x	x	
091 02 05 00	**Standard words and phrases (relevant RTF phraseology included)**						
LO	Define the meaning of 'standard words and phrases'.	x	x	x	x	x	
LO	Use correct phraseology for each phase of VFR flight.	x	x	x	x	x	
LO	Aerodrome procedures: — departure information; — taxiing instructions; — aerodrome traffic and circuits; — final approach and landing; — after landing; — essential aerodrome information.	x	x	x	x	x	
LO	VFR departure.	x	x	x	x	x	
LO	VFR arrival.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
091 02 06 00	**Radio-telephony call signs for aeronautical stations including use of abbreviated call signs**						
LO	Name the two parts of the call sign of an aeronautical station.	x	x	x	x	x	
LO	Identify the call-sign suffixes for aeronautical stations.	x	x	x	x	x	
LO	Explain when the call sign may be omitted or abbreviated to the use of suffix only.	x	x	x	x	x	
091 02 07 00	**Radio-telephony call signs for aircraft including use of abbreviated call signs**						
LO	List the three different ways to compose an aircraft call sign.	x	x	x	x	x	
LO	Describe the abbreviated forms for aircraft call signs.	x	x	x	x	x	
LO	Explain when aircraft call signs may be abbreviated.	x	x	x	x	x	
091 02 08 00	**Transfer of communication**						
LO	Describe the procedure for transfer of communication: — by ground station; — by aircraft.	x	x	x	x	x	
091 02 09 00	**Test procedures including readability scale**						
LO	Explain how to test radio transmission and reception.	x	x	x	x	x	
LO	State the readability scale and explain its meaning.	x	x	x	x	x	
091 02 10 00	**Read-back and acknowledgement requirements**						
LO	State the requirement to read back ATC route clearances.	x	x	x	x	x	

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	State the requirement to read back clearances related to the runway in use.	x	x	x	x	x	
LO	State the requirement to read back other clearances including conditional clearances.	x	x	x	x	x	
LO	State the requirement to read back other data such as runway, SSR codes, etc.	x	x	x	x	x	
091 02 11 00	**Radar procedural phraseology**						
LO	Use the correct phraseology for an aircraft receiving a radar service: — radar identification; — radar vectoring; — traffic information and avoidance; — SSR procedures.	x	x	x	x	x	
091 03 00 00	**RELEVANT WEATHER INFORMATION TERMS (VFR)**						
091 03 01 00	**Aerodrome weather**						
LO	List the contents of aerodrome weather reports and state units of measurement used for each item: — wind direction and speed; — variation of wind direction and speed; — visibility; — present weather; — cloud amount and type (including the meaning of CAVOK); — air temperature and dew point; — pressure values (QNH, QFE); — supplementary information (aerodrome warnings, landing runway, runway conditions, restrictions, obstructions, wind-shear warnings, etc.).	x	x	x	x	x	
091 03 02 00	**Weather broadcast**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	List the sources of weather information available for aircraft in flight.	x	x	x	x	x	
LO	Explain the meaning of the acronyms 'ATIS', 'VOLMET'.	x	x	x	x	x	
091 04 00 00	**ACTION REQUIRED TO BE TAKEN IN CASE OF COMMUNICATION FAILURE**						
LO	State the action to be taken in case of communication failure on a controlled VFR flight.	x	x	x	x	x	
LO	Identify the frequencies to be used in an attempt to establish communication.	x	x	x	x	x	
LO	State the additional information that should be transmitted in the event of receiver failure.	x	x	x	x	x	
LO	Identify the SSR code that may be used to indicate communication failure.	x	x	x	x	x	
LO	Explain the action to be taken by a pilot with communication failure in the aerodrome traffic pattern at controlled aerodromes.	x	x	x	x	x	
091 05 00 00	**DISTRESS AND URGENCY PROCEDURES**						
091 05 01 00	**Distress (definition, frequencies, watch of distress frequencies, distress signal, distress message)**						
LO	State the DISTRESS procedures.	x	x	x	x	x	
LO	Define DISTRESS.	x	x	x	x	x	
LO	Identify the frequencies that should be used by aircraft in DISTRESS.	x	x	x	x	x	
LO	Specify the emergency SSR codes that may be used by aircraft, and the meaning of the codes.	x	x	x	x	x	

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe the action to be taken by the station which receives a DISTRESS message.	x	x	x	x	x	
LO	Describe the action to be taken by all other stations when a DISTRESS procedure is in progress.	x	x	x	x	x	
LO	List the content of a DISTRESS signal/message in the correct sequence.	x	x	x	x	x	
091 05 02 00	**Urgency (definition, frequencies, urgency signal, urgency message)**						
LO	State the URGENCY procedures.	x	x	x	x	x	
LO	Define URGENCY.	x	x	x	x	x	
LO	Identify the frequencies that should be used by aircraft in URGENCY.	x	x	x	x	x	
LO	Describe the action to be taken by the station which receives an URGENCY message.	x	x	x	x	x	
LO	Describe the action to be taken by all other stations when an URGENCY procedure is in progress.	x	x	x	x	x	
LO	List the content of an URGENCY signal/message in the correct sequence.	x	x	x	x	x	
091 06 00 00	**GENERAL PRINCIPLES OF VHF PROPAGATION AND ALLOCATION OF FREQUENCIES**						

Syllabus reference	**Syllabus details and associated Learning Objectives**	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe the radio-frequency spectrum with particular reference to VHF.	x	x	x	x	x	
LO	Describe the radio-frequency spectrum of the bands into which the radio-frequency spectrum is divided.	x	x	x	x	x	
LO	Identify the frequency range of the VHF band.	x	x	x	x	x	
LO	Name the band normally used for Aeronautical Mobile Service voice communication.	x	x	x	x	x	
LO	State the frequency separation allocated between consecutive VHF frequencies.	x	x	x	x	x	
LO	Describe the propagation characteristics of radio transmissions in the VHF band.	x	x	x	x	x	
LO	Describe the factors which reduce the effective range and quality of radio transmissions.	x	x	x	x	x	
LO	State which of these factors apply to the VHF band.	x	x	x	x	x	
LO	Calculate the effective range of VHF transmissions assuming no attenuating factors.	x	x	x	x	x	

P. SUBJECT 092 — IFR COMMUNICATIONS

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
090 00 00 00	**COMMUNICATIONS**						
092 00 00 00	**IFR COMMUNICATIONS**						
092 01 00 00	**DEFINITIONS**						
092 01 01 00	**Meanings and significance of associated terms**						
LO	Stations.	x		x			x
LO	Communication methods.	x		x			x
LO	The terms used in conjunction with the approach and holding procedures.	x		x			x
092 01 02 00	**Air Traffic Control abbreviations**						
LO	Define commonly used Air Traffic Control abbreviations: — flight conditions; — airspace; — services; — time; — miscellaneous.	x		x			x
LO	The additional IFR-related terms.	x		x			x
092 01 03 00	**Q-code groups commonly used in RTF air–ground communications**						
LO	Define Q-code groups commonly used in RTF air-to-ground communications: — pressure settings; — directions and bearings.	x		x			x
LO	State the procedure for obtaining a bearing information in flight.	x		x			x
092 01 04 00	**Categories of messages**						
LO	List the categories of messages in order of priority.	x		x			x
LO	Identify the types of messages appropriate to each category.	x		x			x
LO	List the priority of a message (given examples of messages to compare).	x		x			x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
092 02 00 00	**GENERAL OPERATING PROCEDURES**						
092 02 01 00	**Transmission of letters**						
LO	State the phonetic alphabet used in radio-telephony.	x		x			x
LO	Identify the occasions when words should be spelt.	x		x			x
092 02 02 00	**Transmission of numbers (including level information)**						
LO	Describe the method of transmitting numbers: — pronunciation; — single digits, whole hundreds and whole thousands.	x		x			x
092 02 03 00	**Transmission of time**						
LO	Describe the ways of transmitting time: — standard time reference (UTC); — minutes, minutes and hours, when required.	x		x			x
092 02 04 00	**Transmission technique**						
LO	Explain the techniques used for making good R/T transmissions.	x		x			x
092 02 05 00	**Standard words and phrases (relevant RTF phraseology included)**						
LO	Define the meaning of 'standard words and phrases'.	x		x			x
LO	Use correct standard phraseology for each phase of IFR flight: — pushback; — IFR departure; — airways clearances; — position reporting; — approach procedures; — IFR arrivals.	x		x			x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
092 02 06 00	**Radio-telephony call signs for aeronautical stations including use of abbreviated call signs**						
LO	Name the two parts of the call sign of an aeronautical station.	x		x			x
LO	Identify the call-sign suffixes for aeronautical stations.	x		x			x
LO	Explain when the call sign may be omitted or abbreviated to the use of suffix only.	x		x			x
LO	Name the two parts of the call sign of an aeronautical station.	x		x			x
LO	Identify the call-sign suffixes for aeronautical stations.	x		x			x
LO	Explain when the call sign may be abbreviated to the use of suffix only.	x		x			x
092 02 07 00	**Radio-telephony call signs for aircraft including use of abbreviated call signs**						
LO	List the three different ways to compose an aircraft call sign.	x		x			x
LO	Describe the abbreviated forms for aircraft call signs.	x		x			x
LO	Explain when aircraft call signs may be abbreviated.	x		x			x
LO	Explain when the suffix 'HEAVY' should be used with an aircraft call sign.	x		x			x
LO	Explain the use of the phrase 'Change your call sign to…'.	x		x			x
LO	Explain the use of the phrase 'Revert to flight plan call sign'.	x		x			x
092 02 08 00	**Transfer of communication**						

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	Describe the procedure for transfer of communication: — by ground station; — by aircraft.	x		x			x
092 02 09 00	**Test procedures including readability scale; establishment of RTF communication**						
LO	Explain how to test radio transmission and reception.	x		x			x
LO	State the readability scale and explain its meaning.	x		x			x
092 02 10 00	**Read-back and acknowledgement requirements**						
LO	State the requirement to read back ATC route clearances.	x		x			x
LO	State the requirement to read back clearances related to runway in use.	x		x			x
LO	State the requirement to read back other clearances including conditional clearances.	x		x			x
LO	State the requirement to read back data such as runway, SSR codes, etc.	x		x			x
092 02 11 00	**Radar procedural phraseology**						
LO	Use the correct phraseology for an aircraft receiving a radar service: — radar identification; — radar vectoring; — traffic information and avoidance; — SSR procedures.	x		x			x
092 02 12 00	**Level changes and reports**						
LO	Use the correct term to describe vertical position: — in relation to flight level (standard pressure setting); — in relation to altitude (metres/feet on QNH); — in relation to height (metres/feet on QFE).	x		x			x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
092 03 00 00	**ACTION REQUIRED TO BE TAKEN IN CASE OF COMMUNICATION FAILURE**						
LO	Describe the action to be taken in communication failure on an IFR flight.	x		x			x
LO	Describe the action to be taken in case of communication failure on an IFR flight when flying in VMC and the flight will be terminated in VMC.	x		x			x
LO	Describe the action to be taken in case of communication failure on an IFR flight when flying in IMC.	x		x			x
092 04 00 00	**DISTRESS AND URGENCY PROCEDURES**						
092 04 01 00	**PAN MEDICAL**						
LO	Describe the type of flights to which PAN MEDICAL applies.	x		x			x
LO	List the content of a PAN MEDICAL message in correct sequence.	x		x			x
092 04 02 00	**Distress (definition, frequencies, watch of distress frequencies, distress signal, distress message)**						
LO	State the DISTRESS procedures.	x		x			x
LO	Define DISTRESS.	x		x			x
LO	Identify the frequencies that should be used by aircraft in DISTRESS.	x		x			x
LO	Specify the emergency SSR codes that may be used by aircraft, and the meaning of the codes.	x		x			x
LO	Describe the action to be taken by the station which receives a DISTRESS message.	x		x			x
LO	Describe the action to be taken by all other stations when a DISTRESS procedure is in progress.	x		x			x

Syllabus reference	Syllabus details and associated Learning Objectives	Aeroplane		Helicopter			IR
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	List the content of a DISTRESS message.	x		x			x
092 04 03 00	**Urgency (definition, frequencies, urgency signal, urgency message)**						
LO	State the URGENCY procedures.	x		x			x
LO	Define URGENCY.	x		x			x
LO	Identify the frequencies that should be used by aircraft in URGENCY.	x		x			x
LO	Describe the action to be taken by the station which receives an URGENCY message.	x		x			x
LO	Describe the action to be taken by all other stations when a DISTRESS procedure is in progress.	x		x			x
LO	List the content of an URGENCY signal/message in the correct sequence.	x		x			x
092 05 00 00	**RELEVANT WEATHER INFORMATION TERM**						
092 05 01 00	**Aerodrome weather**						
LO	List the contents of aerodrome weather reports and state units of measurement used for each item: — wind direction and speed; — variation of wind direction and speed; — visibility; — present weather; — cloud amount and type (including the meaning of CAVOK); — air temperature and dew point; — pressure values (QNH, QFE); — supplementary information (aerodrome warnings, landing runway, runway conditions, restrictions, obstructions, wind-shear warnings, etc.).	x		x			x
LO	State units for measurement used for runway visual range.	x		x			x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	State units of measurement used for braking action (friction coefficient).	x		x			x
092 05 02 00	**Weather broadcast**						
LO	List the sources of weather information available for aircraft in flight.	x		x			x
LO	Explain the meaning of the acronyms 'ATIS', 'VOLMET'.	x		x			x
LO	Explain when aircraft routine meteorological observations should be made.	x		x			x
LO	Explain when aircraft special meteorological observations should be made.	x		x			x
092 06 00 00	**GENERAL PRINCIPLES OF VHF PROPAGATION AND ALLOCATION OF FREQUENCIES**						
LO	Describe the radio-frequency spectrum with particular reference to VHF.	x		x			x
LO	State the names of the bands into which the radio-frequency spectrum is divided.	x		x			x
LO	Identify the frequency range of the VHF band.	x		x			x
LO	Name the band normally used for Aeronautical Mobile Service voice communications.	x		x			x
LO	State the frequency separation allocated between consecutive VHF frequencies.	x		x			x
LO	Describe the propagation characteristics of radio transmissions in the VHF band.	x		x			x
LO	Describe the factors which reduce the effective range and quality of radio transmissions.	x		x			x

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/ IR	ATPL	CPL	
LO	State which of these factors apply to the VHF band.	x		x			x
LO	Calculate the effective range of VHF transmissions assuming no attenuating factors.	x		x			x
092 07 00 00	**MORSE CODE**						
LO	Identify radio-navigation aids (VOR, DME, NDB, ILS) from their Morse-code identifiers.	x	x	x	x	x	x
LO	SELCAL, TCAS, ACARS phraseology and procedures.	x	x	x	x	x	x

(b) Airship

SYLLABUS OF THEORETICAL KNOWLEDGE FOR CPL AND IR

The applicable items for each licence or rating are marked with ‘x’. An ‘x’ on the main title of a subject means that all the subdivisions are applicable.

4. References

4.1. Affected regulations

Commission Regulation (EU) No 1178/2011 of 3 November 2011 laying down technical requirements and administrative procedures related to civil aviation aircrew pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council (OJ L 311, 25.11.2011, p. 1), as amended by Commission Regulation (EU) No 290/2012 of 30 March 2012 (OJ L 100, 5.4.2012, p. 1), Commission Regulation (EU) No 70/2014 of 27 January 2014 (OJ L 23, 28.1.2014, p. 25), and Commission Regulation (EU) No 245/2014 of 13 March 2014 (OJ L 74, 14.3.2014, p. 33)

4.2. Affected CS, AMC and GM

Annex to ED Decision 2011/016/R of 15 December 2011 on 'Acceptable Means of Compliance and Guidance Material to Part-FCL' (Acceptable Means of Compliance and Guidance Material to Commission Regulation (EU) No 1178/2011 of 3 November 2011 laying down technical requirements and administrative procedures related to civil aviation aircrew pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council)

Annex to ED Decision 2014/022/R of 1 April 2014 on 'AMC and GM to Part-FCL – Amendment 1' (amending the Acceptable Means of Compliance and Guidance Material to Part-FCL of Commission Regulation (EU) No 1178/2011 of 3 November 2011 laying down technical requirements and administrative procedures related to civil aviation aircrew pursuant to Regulation (EC) No 216/2008 of the European Parliament and of the Council)

4.3. Reference documents

Not applicable.

5. Appendices

Not applicable.