## Subject No. 42 ATPL Meteorology

***NOTE:*** *This syllabus is principally based on regional/oceanic/global IFR applicable meteorology appropriate to navigating a multi engine turbine air transport type aeroplane or IFR capable turbine helicopter operating at all altitudes.*

*Detailed acronyms and service provider titles (e.g. ETOPS, OPMET) are constantly changing and thus are indicative of the area of knowledge required and do not limit this syllabus to those specifically listed.*

Each subject has been given a subject number and each topic within that subject a topic number. These reference numbers will be used on knowledge deficiency reports and will provide valuable feedback to the examination candidate. These reference numbers are common across the subject levels and therefore may not be consecutive.

This syllabus presupposes a thorough knowledge and understanding of the PPL and CPL Meteorology syllabus. Any item repeated here indicates a higher level of understanding or a wider scope is required.

**Sub Topic Syllabus Item**

**42.2 International Meteorological Services, Reports and Forecasts**

42.2.2 Briefly explain the purpose of and the types of meteorological information available to international aviation through the:

World Area Forecast System (WAFS)

(a) World Area Forecast System (WAFS)

(b) Volcanic Ash Advisory Centres (VAAC)

(c) Tropical Cyclone Warning Centres (TCWC).

42.2.4 For international operations, interpret information contained in all the available meteorological services, reports and forecasts, including:

(a) route forecasts

(b) OPMET (TAF, VOLMET, METAR/SPECI, METAR AUTO, TREND, SIGMET, VAA, AIREP).

42.2.6 For international operations, assess the impact of information contained in the services, reports and forecasts at 42.2.4.

42.2.8 With reference to a given ROFOR:

(a) determine the route to which the forecast applies

(b) determine the issue and validity times of the ROFOR in relation to ETD and ETA

(c) interpolate the wind velocity and temperature to any height and location within the forecast data provided in a ROFOR.

42.2.10 With respect to WIND/TEMP forecast charts:

(a) identify the issue time and validity time

(b) identify the office issuing the chart

(c) identify the Flight Level of the chart

(d) identify and assess the impact of wind and temperature information contained in the chart.

42.2.12 Describe the phenomenon known as soft hail (also known as graupel or snow pellets.

42.2.14 With respect to medium-level and high-level SIGWX charts:

(a) identify the issue time and validity period

(b) identify the office issuing the chart

(c) determine the height range covered by the chart

(d) state the meaning of all the meteorological symbols on the chart.

42.2.16 With respect to medium and high-level SIGWX charts, interpret and assess information related to significant areas of:

(e) cloudiness

(a) tropical cyclones

(b) jet-streams

(c) clear-air turbulence

(d) icing

(e) volcanic eruptions

(f) tropopause height.

**42.4 Weather Maps**

42.4.2 For international operations, interpret, and assess the impact of information contained in surface synoptic charts (where available around the globe).

42.4.4 Describe what is meant by ‘streamline analysis.’

42.4.6 State the reason why ‘streamline analysis’ is necessary at tropical latitudes.

42.4.8 Interpret basic streamline patterns commonly shown on streamline charts (e.g. inflows, outflows etc).

**42.6 The Atmosphere**

42.6.2 With respect to the tropopause:

(a) describe the idealised global tropopause detailing approximate altitudes and the position of jet-streams

(b) explain why the height of the tropopause varies with latitude and season.

42.6.4 Explain why the stratosphere is generally devoid of cloud and turbulence.

**42.8 Temperature and Heat Exchange Processes**

42.8.2 Describe the following units of temperature:

(a) Celsius

(b) Fahrenheit

(c) absolute (Kelvin).

42.8.4 Convert between Celsius, Fahrenheit and absolute temperatures.

42.8.6 Explain what is meant by the terms ‘solar radiation’ and ‘terrestrial radiation’.

42.8.8 State the wave-length of ‘solar radiation’ and ‘terrestrial radiation’.

42.8.10 Describe the effect of the following on the amount of solar radiation received at the surface of the earth:

(a) sun angle

(b) length of day

(c) season.

42.8.12 Define the terms:

(a) ‘solstice’

(b) ‘equinox’.

42.8.14 State the significance of:

(a) ‘solstice’

(b) ‘equinox’.

**42.10 Pressure and Density**

42.10.2 State the meteorological units of pressure used in:

(a) Australia

(b) USA.

42.10.4 Demonstrate the effect of flying at a constant indicated altitude from a cold region to a warm region, during which the surface pressure does not change.

42.10.6 State the difference between:

(a) ISA

(b) jet standard atmosphere.

42.10.8 Convert ISA temperature at altitude to °C ambient and vice versa.

**42.12 Wind**

42.12.2 Describe the basic concepts expressed in the horizontal component of the Coriolis force formula.

42.12.4 Describe the development of the geostrophic wind balance in both hemispheres.

42.12.6 Describe the development of the gradient wind balance in both hemispheres.

42.12.8 Given equal spacing between isobars, explain why the wind speed is stronger around an anticyclone (high) than around a depression (low).

42.12.10 Demonstrate the effects of friction on surface wind in both hemispheres.

42.12.12 For both hemispheres:

(a) describe the typical diurnal variation of surface wind

(b) state the change in wind velocity when climbing out of, or descending into, the friction layer.

**42.16 Water Vapour**

42.16.2 Interpret a graph of saturation water vapour content against temperature, and calculate dew point and relative humidity from the graph.

**42.18 Atmospheric Stability**

42.18.2 Given the MSL temperature on the windward side of a mountain range, cloud base heights to windward and leeward of the range, and mountain range height (AMSL), determine:

(a) if it is raining on the windward side of the range

(b) the temperature at the cloud bases (to windward and leeward of the ranges)

(c) the temperature at mountain top

(d) the temperature at MSL on the lee side of the range.

42.18.4 Explain why the SALR steepens with increasing height and increasing latitude.

**42.22 Cloud**

42.22.2 Describe the effect of latent heat release on stability inside a cloud and its influence on the resulting cloud type.

42.22.4 With regard to orographically developed cloud:

(a) explain the influence of stability/instability and different surface dew point values on the type and vertical extent of any cloud formed

(b) describe the formation and characteristics of lenticular cloud.

**42.28 Aircraft Icing**

42.28.2 Explain the following processes:

(a) deposition

(b) sublimation.

42.28.4 Explain what happens when an aircraft collides with ‘super-cooled water droplets’ (SCWD).

42.28.6 Describe the ‘freezing rain’ formation process.

42.28.8 State the areas of the globe where freezing rain is most likely to be encountered.

42.28.10 Identify the symbols used to indicate:

(a) light icing

(b) moderate icing

(c) severe icing.

## 42.30 Thunderstorms

42.30.2 Explain the importance of latent heat in the development of thunderstorms.

42.30.4 Describe the effect of entrainment of drier air aloft on the development of thunderstorms.

42.30.6 Describe the processes involved in the development of lightning.

42.30.8 Describe the following hazards associated with flight in and around thunderstorms:

(a) turbulence

(b) gusts and squalls

(c) icing

(d) lightning

(e) hail

(f) poor visibility

(g) tornadoes

(h) microbursts

(i) first gust (or gust front)

(j) noise

(k) loss of instruments and impairment of accuracy.

42.30.10 Describe the characteristics of super-cell thunderstorms.

## 42.36 Fronts and Depressions

42.36.2 Explain what is meant by air-mass modification.

42.36.4 Describe the following factors associated with either ‘cold air advection’ or ‘warm air advection’:

(a) stability

(b) cloud types

(c) likely precipitation

(d) visibility reductions

(e) turbulence.

42.36.6 Describe the concepts of convergence and divergence.

42.36.8 Explain the vertical motions generated by convergence and divergence near the earth’s surface and immediately beneath the tropopause.

42.36.10 Explain the concept of vorticity (rotation or spin).

42.36.12 Explain how convergence drives an increase in vorticity through conservation of angular momentum.

42.36.14 Outline the effect of vorticity advection on the development of mid-latitude pressure systems.

42.36.16 With respect to depressions of the Southern Hemisphere outside the tropics, describe the development and associated cloud of the:

(a) mid to high-latitude depression, where upper-level divergence dominates the formation process

(b) sub-tropical depression, where advection of warm moist air and latent heat release dominate the formation process.

42.36.18 Describe the effect of the following on the intensity of fronts, and on the extent of cloud and precipitation:

(a) amount of moisture in the warm rising air

(b) stability or instability of the rising air

(c) the slope of the frontal surface

(d) the speed of the front

(e) the temperature contrast across the front.

42.36.20 Describe the sequence of events during the passage of an idealised cold front and warm front (or warm sector) in both hemispheres, in terms of:

(a) pressure changes

(b) temperature changes

(c) cloud

(d) precipitation

(e) visibility

(f) dew point changes.

42.36.22 Explain the concept of an occluded front.

## 42.38 Upper Air Meteorology

42.38.2 Define:

(a) height contour

(b) isotherm.

42.38.4 Describe the use of height contour charts in the forecasting of upper winds.

42.38.6 State the information that can be obtained from spacing and orientation of height contour lines.

42.38.8 Outline the definition of the ‘thermal wind’.

42.38.10 Outline how wind at higher altitudes is a vector sum of the lower level wind and the thermal wind through the layer.

42.38.12 Explain why the wind at progressively higher altitudes in mid-latitudes tends to become stronger, and more westerly.

42.38.14 Define ‘jet-stream’.

42.38.16 Describe the structure of a jet-stream including the occurrence of wind shear and turbulence.

42.38.18 Identify the four principal jet-streams found globally within the troposphere.

42.38.20 With regard to the Southern Hemisphere polar jet-stream, describe its:

(a) connection to low-level fronts and thermal gradients

(b) location relative to the frontal interface

(c) typical altitude

(d) variations in intensity and latitude from winter to summer

(e) probable areas for turbulence.

42.38.22 With regard to the Southern Hemisphere sub-tropical jet-stream, describe its:

(a) disconnection from low-level fronts

(b) location relative to the fractured tropopause

(c) typical altitude

(d) variations in intensity and latitude from winter to summer

(e) probable areas for turbulence.

42.38.24 Explain where and why cirrus cloud is likely to form in relation to a jet-stream.

42.38.26 Explain the characteristic ‘tilt’ with height of developing mid-latitude depressions and anticyclones.

42.38.28 Describe how mountain waves can combine with jet-streams to generate severe clear air turbulence.

42.38.30 Describe how a pilot can anticipate the location and altitude of jet-streams.

42.38.32 Explain the tell-tale signs that are often present in flight to indicate a jet-stream.

**42.40 Turbulence**

42.40.2 Define clear air turbulence (CAT).

42.40.4 State the difference between turbulence and up/down draughts.

**42.42 Other Hazardous Meteorological Conditions**

42.42.2 Describe the effects of volcanic ash on aircraft operations.

42.42.6 Explain the development of visual-illusion type whiteout and sector whiteout.

42.42.8 Describe the hazards of flight in whiteout conditions.

## 42.46 The General Circulation

42.46.2 State the dominant factors that control the transfer of heat around the globe.

42.46.4 Explain what is meant by:

(a) ‘zonal index’

(b) ‘zonal winds’.

42.46.6 Describe:

(a) ‘high zonal index’

(b) ‘low zonal index’.

42.46.8 State how ‘high’ zonal index’ and ‘low zonal index’ relate to the:

(a) speed and direction of low tropospheric weather systems

(b) strength and uniformity of upper-level westerlies and jet-streams.

42.46.10 Define the terms:

(a) long atmospheric waves

(b) medium atmospheric waves

(c) short atmospheric waves.

42.46.12 Describe what is meant by the terms:

(a) ‘cold pool’

(b) ‘warm pool’.

42.46.14 Describe the characteristics of:

(a) maritime climates

(b) continental climates.

## 42.48 Tropical Meteorology

42.48.2 Explain what is meant by:

(a) equatorial trough (meteorological – or thermal – equator)

(b) inter-tropical convergence zone (ITCZ)

(c) South Pacific convergence zone (SPCZ).

42.48.4 Relative to the equatorial trough, state the region where the following occurs:

(a) maximum convergence

(b) maximum convection

(c) maximum cloud development.

42.48.6 Describe the following features commonly associated with an ‘active’ or an ‘inactive’ ITCZ:

(a) weather

(b) icing

(c) turbulence

(d) cloud-related factors.

42.48.8 Describe the preferred location and characteristics of the South Pacific Converge Zone.

42.48.10 Interpret a simplified diagram of the tropical Hadley Cell showing the pattern of horizontal mixing in mid- and high-latitudes of both hemispheres.

42.48.12 Use diagrams to explain the following aspects of the ‘Trade Winds’ in both hemispheres of the Pacific Ocean:

(a) typical horizontal wind directions at low, middle, and upper levels

(b) anticyclonic subsidence and associated meteorological conditions

(c) approximate latitudinal and vertical limits

(d) seasonal changes in location and their effect on wind direction

(e) typical wind strengths, including variation from summer to winter

(f) the effect of the trade winds on the weather experienced in island groups and northern Australia.

42.48.14 Outline how tropical convection can occur as individual convective cells or as organised clusters.

42.48.16 Describe the factors involved in wet monsoons in terms of:

(a) seasonal factors

(b) effect of large land masses and orographic obstructions

(c) the location of the major monsoon regions.

42.48.18 State the global basins where the following form:

(a) tropical cyclones

(b) typhoons

(c) hurricanes.

42.48.20 With regard to the formation, development and decay of tropical cyclones, describe the:

(a) relationship with the equatorial trough and/or the SPCZ

(b) requirement for, and supply of, sensible and latent heat

(c) effect of upper-level divergence

(d) characteristics of the cyclone ‘eye’

(e) requirement for a ‘warm core’.

42.48.22 State the stages of development of tropical cyclones.

42.48.24 For each stage of development, describe the:

(a) atmospheric pressure tendency

(b) typical wind strengths, including variations in wind velocity in, and either side of, the cyclone eye

(c) typical radii of the affected areas

(d) associated weather, and the location of the most severe conditions.

42.48.26 Describe the mechanisms for the decay of tropical cyclones.

42.48.28 State the season during which tropical cyclones are generally experienced.

42.48.30 Describe the Walker Cell in the South Pacific ocean.

42.48.32 Define the ENSO index.

42.48.34 Outline the characteristics of positive (La Niña) and negative (El Niño) phases of the ENSO index, including the effect on:

(a) prevailing winds in tropical and mid-latitude regions

(b) meteorological conditions in Australasia.

**42.50 Satellite and Radar Imagery**

42.50.2 Describe how infra-red and visible satellite imagery can be used together to provide information on the:

(a) areal extent of cloud

(b) height of the cloud top

(c) types of cloud

(d) movement of cloud

(e) likely weather within the area of coverage of the satellite.

42.50.4 For international operations interpret and assess the impact of given examples of satellite imagery.

42.50.6 Describe how, within the coverage of the radar(s), radar imagery can be used to provide information on:

(a) the areal extent of precipitation

(b) intensity of precipitation

(c) movement of precipitation

(d) duration of precipitation.

(e) 42.50.8 For international operations interpret and assess the impact of given examples of radar imagery.