Subject No 42 - ATPL Meteorology

Notes: 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 feed back 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
	Fundamentals of the atmosphere
42.2	**The atmosphere**
42.2.2	Define: (a) tropopause; (b) troposphere; (c) stratopause; (d) stratosphere; (e) insolation.
42.2.4	Interpret a graph of temperature versus altitude from the earth's surface to the stratopause, and explain why the shape of the curve is different in the troposphere compared to the stratosphere.
42.2.6	Describe the following features of the troposphere; (a) approximate vertical extent at low, middle and high latitudes; (b) general weather and turbulence expected within the troposphere.
42.2.8	Explain the importance of the various elements in the atmosphere.
42.2.10	With respect to the tropopause: (a) describe the idealised global tropopause detailing approximate altitudes and the position of jet streams; (b) explain why the altitude of the tropopause varies with latitude; (c) explain how the tropopause pattern responds to the seasons in the northern and southern hemisphere.
42.2.12	Describe the relationship between the temperature of the tropopause and the temperature of the lower stratosphere.
42.2.14	Explain the relationship between angle of insolation, atmospheric temperature and tropopause height.
42.2.16	Explain why the stratosphere is generally devoid of cloud and turbulence.
42.4	**Atmospheric Pressure**
42.4.2	State the meteorological units of pressure used in;

Sub Topic	Syllabus Item
	(a) Australia; (b) USA.
42.4.4	Calculate pressure lapse rates given temperatures and pressure levels.
42.4.6	State the average pressure lapse rate in the lower troposphere.
42.4.8	Define the following pressure systems, and state the direction of circulation around the systems in both hemispheres: (a) anticyclone (or 'high'); (b) depression (or "low"); (c) ridge of high pressure; (d) trough of low pressure; (e) col.
42.4.10	Describe the meteorological conditions commonly associated with and explain the causes of, in both hemispheres: (a) anticyclone (or "high"); (b) depression (or "low"); (c) ridge of high pressure; (d) trough of low pressure; (e) col.
42.4.12	With respect to the semi-diurnal variation of pressure: (a) describe the process; (b) explain the cause(s) of the semi-diurnal variation of pressure; (c) state the latitudes where the semi-diurnal variation of pressure is most evident.
42.4.14	Explain the cause of pressure gradient and the factors that determine its strength.
42.4.16	Describe the relationship between pressure gradient, isobars and wind speed.
42.4.18	State the conditions on which the International Standard Atmosphere (ISA) is based.
42.4.20	Explain the importance and application of the ISA to aviation.
42.4.22	State the temperature and pressure lapse rates in the: (a) ISA (b) Jet Standard Atmosphere.
42.4.24	Convert ISA temperature at altitude to °C ambient and vice versa.
42.6	**Temperature and Heat Exchange Processes**
42.6.2	Describe the following units of measurement of temperature: (a) Celsius; (b) Fahrenheit; (c) Absolute (Kelvin).
42.6.4	Demonstrate proficiency in converting Celsius to Fahrenheit and Absolute, and any combination of these.
42.6.6	Explain the relationship between the temperature of a heat source and radiation frequency.
42.6.8	State the frequency band and wave length of:

Sub Topic	Syllabus Item
	(a) solar radiation;
	(b) terrestrial radiation.
42.6.10	Explain what is meant by ‘solar radiation’, and state the components, and their percentage values, that make up solar radiation.
42.6.12	Explain how the components of solar radiation are affected by:
	(a) absorption;
	(b) reflection;
	(c) scattering.
42.6.14	Explain what is meant by:
	(a) sky radiation;
	(b) global solar radiation.
42.6.16	Describe the effect of the following on the amount of solar radiation received by earth:
	(a) distance between sun and earth;
	(b) sun angle;
	(c) length of day.
42.6.18	Explain what is meant by and the significance of:
	(a) solstice;
	(b) equinox.
42.6.20	Explain what is meant by ‘terrestrial radiation’, and state the type of radiation involved.
42.6.22	List the atmospheric constituents that have the potential to hinder the escape of terrestrial radiation.
42.6.24	Explain the ‘greenhouse’ effect.
42.6.26	Explain what is meant by the:
	(a) ‘atmospheric window’;
	(b) ‘energy budget’.
42.6.28	Explain what is meant by:
	(a) sensible heat;
	(b) specific heat.
42.6.30	With the aid of graphs, describe the diurnal variation of surface air temperature.
42.6.32	Explain how, and why, the following factors influence the diurnal variation of surface air temperature:
	(a) type of surface;
	(b) oceans and other large water areas;
	(c) water vapour;
	(d) cloud;
	(e) wind.
42.6.34	Describe the characteristics of global maritime and continental climates.
42.8	**Atmospheric Moisture**
42.8.2	Interpret a typical graph of water vapour at saturation against temperature, and calculate relative humidity from information provided by the graph.

Sub Topic	Syllabus Item
42.10	**Wind**
42.10.2	Explain the relationship between insolation and movement of air, both horizontally and vertically.
42.10.4	Explain the effect of Coriolis force on the movement of air in the northern and southern hemisphere, and state the direction of the force and its strength relative to the flow of air.
42.10.6	Describe the basic concepts expressed in the Coriolis formula.
42.10.8	Describe the effect of Coriolis force and pressure gradient on the movement of air relative to the isobars.
42.10.10	Describe the inter-relation between pressure gradient, Coriolis force, and centrifugal force on the curvature of isobars around high and low pressure systems in the northern and southern hemisphere.
40.10.12	Given equal spacing between isobars, explain why the wind strength is stronger around a high than around a low.
42.10.14	For the northern and southern hemisphere: (a) describe the typical diurnal variation of the surface wind; (b) state the change in wind velocity when climbing out of, or descending into, the friction layer.
42.12	**Stability of Air**
42.12.2	Describe the following processes: (a) adiabatic; (b) non-adiabatic; (c) isobaric.
42.12.4	Using temperature versus altitude graphs, explain how stability and instability of unsaturated air can be determined.
42.12.6	Explain what is meant by: (a) convective stability; (b) latent instability.
42.18	**Cloud**
42.18.2	Describe the effect of latent heat release on stability inside cloud and its influence on the resulting type of cloud.
42.18.4	Describe three causes that tend to slow down the growth of water drops once droplets have formed on nuclei.
42.18.6	Name and describe the appearance and characteristics of the ten main types of cloud sub-divided as: (a) high cloud; (b) middle cloud; (c) low cloud.
42.18.8	With regard orographic cloud: (a) explain the influence of stability/instability of air, and different surface dew point values, on the type and vertical extent of cloud formed orographically; (b) describe the formation and characteristics of lenticular cloud.
42.22	**Visibility**

Sub Topic	Syllabus Item
42.22.2	Explain why solar and lunar illumination do not affect visibility.
42.22.4	Explain the factors involved in: (a) slant range; (b) runway visual range.
42.22.6	Explain the measurement of RVR.
42.26	**Fronts and Depressions**
42.26.2	Explain what is meant by synoptic meteorology.
42.26.4	Define “air mass” and state the three properties that determine the uniformity of an air mass.
42.26.6	Explain what is meant by “source region” and; (a) state the location of the predominant global source regions; and (b) describe how (source region) anticyclones facilitate air masses to absorb the characteristics of the source region.
42.26.8	List the types of air masses and describe the main characteristics, and typical meteorological conditions, of each.
42.26.10	Explain what is meant by air mass modification.
42.26.12	Describe the likely weather conditions experienced in Equatorial and Continental regions during: (a) cold advection; (b) warm advection.
42.26.14	Explain the concept of convergence and divergence.
42.26.16	Explain what is meant by “vorticity advection” and describe its influence on the formation and development of pressure systems and fronts.
42.26.18	With respect to depressions found in mid latitudes of the southern hemisphere, describe the development and associated cloud of: (a) the typical mid latitude depression; (b) the polar depression; (c) sub tropical depression.
42.26.20	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 front; (d) the speed of the front; (e) the temperature contrast across the front.
42.26.22	Interpret the symbols commonly used to denote frontal weather on international charts.
42.26.24	Describe the sequence of events with the passage of the ‘idealised’ cold front and warm front in both hemispheres in terms of: (a) pressure trend; (b) temperature trend; (c) cloud; (d) precipitation;

Sub Topic	Syllabus Item
	(e) visibility;
	(f) dew point trend;
	(g) relative humidity trend.
42.26.26	Explain factors involved in the formation and development of:
	(a) warm occlusions;
	(b) cold occlusions.
42.26.28	State the typical weather conditions during the passage of a warm sector depression.
42.26.30	Explain the associated weather, and factors involved, in the formation and development of:
	(a) an orographic depression;
	(b) a thermal (heat type) depression.
42.28	**Thunderstorms**
42.28.2	Explain the influence of latent heat in the development of thunderstorms.
42.28.4	Describe the effect of entrainment of colder air aloft on the development of thunderstorms.
42.28.6	Describe the processes involved in lightning.
42.28.8	State the three stages of development of thunderstorms, and describe the main factors involved in each stage.
42.28.10	Explain the factors involved in regeneration of thunderstorms.
42.28.12	Describe the following types of thunderstorm:
	(a) orographic type;
	(b) heat type (thermally induced);
	(c) convergence type;
	(d) nocturnal equatorial type;
	(e) cold stream type;
	(f) frontal type.
42.28.14	Describe the following hazards associated with flight in the presence of thunderstorms:
	(a) turbulence;
	(b) vertical draughts;
	(c) gusts and squalls;
	(d) wind shear;
	(e) icing;
	(f) lightning;
	(g) hail;
	(h) noise;
	(i) loss of instruments and impairment of accuracy.
42.28.16	With respect to downbursts, microburst’s and tornadoes, describe their:
	(a) formation and development;
	(b) recognition;
	(c) structure;

Sub Topic	Syllabus Item
	(d) precipitation;
	(e) turbulence and draughts;
	(f) hazards to aviation;
	(g) most likely locations – globally.
42.30	**Icing**
42.30.2	Explain the following processes:
	(a) deposition;
	(b) sublimation.
42.30.4	Describe the processes involved when water changes to ice through the unstable supercooled stage to the stable solid state.
42.30.6	Explain the importance of heat energy (expressed in joules) in the process of changing the temperature of water, and changing the state of water.
42.30.8	Explain the sequence of events when supercooled water is disturbed by an aircraft in flight.
42.30.10	Describe the formation and characteristics of:
	(a) soft hail or graupel;
	(b) snow pellets.
42.30.12	Explain the effect on the height of the freezing level when stable saturated air or unstable saturated air is lifted orographically.
42.30.14	State the:
	(a) potential for ice accretion in the 10 main cloud types and in lenticular cloud;
	(b) type of ice to be expected in each cloud type;
	(c) height bands relative to the freezing level where clear or rime ice can be expected in each cloud type.
42.30.16	Identify the associated symbol indicating;
	(a) light icing;
	(b) moderate icing;
	(c) severe icing.
42.32	**Turbulence**
42.32.2	Define clear air turbulence (CAT).
42.32.4	Differentiate between turbulence and up/down draughts.
42.34	**Upper Air Meteorology**
42.34.2	Define:
	(a) contour line;
	(b) thermal wind;
	(c) isotherm;.
42.34.4	State the information that can be obtained from spacing and orientation of contour lines.
42.34.6	Demonstrate proficiency in interpreting information contained on a contour chart.
42.34.8	Explain the factors involved in determining a thermal wind.
42.34.10	Explain why the wind at progressively higher altitudes in mid latitudes tends to become

Sub Topic	Syllabus Item
	westerly.
42.34.12	Describe the vertical variation of pressure within low level: (a) depressions with a cold core; (b) depressions with a warm core; (c) anticyclones with a cold core; (d) anticyclones with a warm core.
42.34.14	State the characteristic slope (“lean”) of axis of cold depressions and warm anticyclones with altitude in the southern hemisphere.
42.34.16	Define “jet stream”.
42.34.18	Describe the structure of a jet stream including explanations of wind shear and turbulence.
42.34.20	List the four principal jet streams located globally in the troposphere.
42.34.22	Regarding the Southern Hemisphere polar jet stream, describe its: (a) association with fronts and thermal gradients; (b) location relative to the frontal interface; (c) usual, or typical, altitude; (d) intensity and latitudinal location in winter compared to summer; (e) preferred regions of turbulence.
42.34.24	Regarding the Southern Hemisphere subtropical jet stream, describe/state: (a) the origin of its associated thermal gradient; (b) its location relative to the fractured tropopause; (c) its usual altitude; (d) the region where the strongest turbulence is generally found.
42.34.26	State the season during which jet streams are more active as the result of differing global thermal gradients.
42.34.28	With respect to (clear air) turbulence associated with jet streams, describe or state the: (a) relationship between wind shear value and severity of turbulence; (b) regions where clear air turbulence is likely to be found; (c) effect on the severity of turbulence where mountain waves and jet stream combine.
42.34.30	With respect to cloud formations associated with jet streams, describe or state the type of cloud commonly found on the: (a) warm side of the jet stream; (b) cold side of the jet stream.
42.34.32	Describe how a pilot can anticipate the location and altitude of jet streams, and what telltale signs are often present in flight to locate a jet stream.
42.34.34	With respect to polar and subtropical jet streams in both hemispheres, list their locations and characteristics in terms of: (a) average wind velocity (direction and speed); (b) average pressure altitude; (c) typical maximum wind speed;

Sub Topic	Syllabus Item
	(d) average latitudinal location.
	Tropical Meteorology
42.38	**Tropical Meteorology**
42.38.2	Interpret a simplified diagram of the tropical Hadley Cells (one in each hemisphere) showing the pattern of horizontal mixing in mid and high latitudes of both hemispheres.
42.38.4	Explain what is meant by: (a) meteorological (or thermal) equator; (b) equatorial trough; (c) intertropical convergence zone (ITCZ) ; (d) South Pacific convergence zone.
42.38.6	Describe the seasonal location of the equatorial trough, and explain the reasons for the change in location.
42.38.8	State the region where maximum convergence, convection and cloud developments are found relative to the equatorial trough.
42.38.10	Describe the essential difference between ‘equatorial trough’ and ‘inter-tropical convergence zone’.
42.38.12	Describe the weather, icing, turbulence and cloud-related factors commonly associated with an: (a) ‘active’ ITCZ; (b) ‘inactive’ ITCZ.
42.38.14	Describe the origin, preferred location, and characteristics of the South Pacific Converge Zone.
42.38.16	With the aid of diagrams, explain the following aspects of the ‘trade winds’ in both hemispheres of the Pacific Ocean: (a) flow pattern; (b) anti-cyclonic subsidence and associated meteorological conditions; (c) approximate horizontal and vertical limits; (d) typical wind velocity normally found above the trade wind zone; (e) seasonal changes in location and their effect on wind direction; (f) typical wind strengths, including variation in strength during the summer and winter; (g) the effect of the trade winds on the weather experienced in island groups and northern Australia.
42.38.18	Describe the following disturbances experienced in tropical latitudes: (a) individual cumulus disturbances; (b) mesoscale convective areas; (c) wave disturbances.
42.38.20	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.

Sub Topic	Syllabus Item
42.38.22	With regard to the formation, development and decay of tropical cyclones, describe the: (a) relationship with the equatorial trough; (b) requirement for, and supply of, thermal energy; (c) effect of high level divergence; (d) mechanics of formation, and characteristics, of the 'cyclone eye'; (e) requirement for a 'warm core'.
42.38.24	State the four stages of development of tropical cyclones.
42.38.26	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 within the cyclone where the worst conditions are commonly experienced.
42.38.28	Describe the common causes that lead to the decay of tropical cyclones.
42.38.30	State the season during which tropical cyclones are generally experienced.
42.38.32	Explain what is meant by the Walker Circulation based on the factors involved in the: (a) east of the South Pacific Ocean; (b) west of the South Pacific Ocean.
42.38.34	Define the ENSO Index, describe the factors involved when the index changes from positive to negative and include the effect of these changes on: (a) prevailing winds in tropical and mid latitude regions; (b) meteorological conditions experienced in Australasia.
42.38.36	Describe what is meant by 'streamline analysis' and state the reason why this analysis is necessary in tropical latitudes.
42.38.38	Define 'isotach' and demonstrate proficiency in interpreting information provided by isotachs on a chart.
42.38.40	Interpret examples of streamline patterns commonly shown on streamline charts (e.g. inflows, outflows etc).
	Global Meteorology
42.40	**The General Circulation**
40.40.2	State the predominant factors that control the transfer of heat around the globe.
42.40.4	Explain what is meant by 'zonal index', and 'zonal winds'.
42.40.6	Describe 'high zonal index' and 'low zonal index', and state how these situations relate to the: (a) speed and direction of low tropospheric weather systems; (b) strength and uniformity of upper level westerlies and jet streams.
42.40.8	Explain what is meant by the term "Short Waves".
42.40.10	Describe the processes involved in the development of a 'blocking anticyclone', and explain its influence on meteorological conditions in New Zealand when the system is to the west of the country and when it is to the east.

Sub Topic	Syllabus Item
42.40.12	Explain what is meant by the terms ‘cold pools’ and ‘warm pools’.
	Hazardous Meteorological Conditions
42.42	**Hazardous meteorological conditions**
42.42.2	Describe the effects of volcanic ash on aircraft operations.
	Meteorological Services to Aviation
42.48	**International meteorological services, reports and forecasts**
42.48.2	Describe the World Area Forecast System (WAFS), Volcanic Ash Advisory Centre (VAAC), Tropical Cyclone Advisory Centre (TCAC) and explain the role played by these and other NZ authorities in providing meteorological services in the Auckland Oceanic and NZ FIR.
42.48.4	Describe the functions of Automatic Weather Stations and state the standard information normally available to aviation.
42.48.6	Explain the limitations of some data obtained from automatic weather stations.
42.48.8	Describe the information normally obtained from radiosondes and state the principle of operation of instruments and equipment carried by radiosondes.
42.48.10	Describe the meteorological products and services available to aviation for both domestic and international operations.
42.48.12	For International operations, interpret, understand and assess information contained in all the available Meteorological Services, Reports and Forecasts, including: (a) Surface synoptic charts; (b) Forecast upper level wind and temperature charts; (c) Satellite imagery; (d) Radar imagery; (e) Significant weather charts; (f) Route forecasts; (g) Freezing level charts; (h) Grid point winds and temperatures; (i) OPMET (TAF, METAR/SPECI, METAR AUTO, TREND, SIGMET) (j) Pilot reports.
42.48.14	With respect to wind and temperature forecast charts: (a) determine issue time and validity period; (b) identify the Office issuing the chart; (c) identify the flight level for the chart; (d) explain the meaning of chart symbols; (e) interpret temperature information.
42.48.16	State the functions, and information available, from the following charts: (a) Effective Wind Component charts; (b) ETOPS TAT charts.
42.48.18	With respect to Mid-level and High-level SIGWX Prognosis Charts: (a) determine the geographical and vertical airspace covered; (b) state Significant Weather items shown;

Sub Topic	Syllabus Item
	(c) determine the Office issuing the chart;
	(d) determine issue and valid time;
	(e) identify, interpret and assess significant zones of cloudiness, tropical cyclones, jet streams, clear air turbulence, icing, tropopause height.
42.48.20	State the issue time relative to ETD, and usual validity time relative to ETA applicable to Route Forecasts (ROFOR).
42.48.22	With respect to a specific ROFOR:
	(a) determine the route to which the forecast applies;
	(b) determine the issue and validity time of the ROFOR;
	(c) determine, through interpolation if necessary, the forecast wind velocity and temperature at any required pressure altitude;
	(d) interpret and assess SIGWX information.