Subject No 20 - CPL Meteorology

Notes: This syllabus is principally based on the regional meteorology as applicable to flying a twin engine aircraft IFR, within the South Pacific region at or below FL 250.

Detailed acronyms and service provider titles (e.g. SKC, METAR AUTO) are indicative of the area of knowledge required and do not limit the 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 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
20.2	**The atmosphere**
20.2.2	Explain how atmospheric temperature influences the capacity of air to hold water vapour.
20.2.4	Describe the effect of: (a) latitude and altitude on water vapour presence; (b) changes to the state of water on the weather.
20.2.6	Explain the manner in which water vapour is added to, and removed from the atmosphere.
20.2.8	Describe the importance and effects of salt, dust and other solid particles in the atmosphere.
20.2.10	Interpret a graph of temperature versus altitude from the earth's surface to the stratopause.
20.2.12	Define 'tropopause'.
20.2.14	Define 'insolation'.
20.2.16	Explain how the temperature/pressure lapse rates generally determine the temperature and altitude of the tropopause.
20.2.18	Describe the relationship between tropopause height and tropopause temperature at various latitudes.
20.2.20	Explain the processes of: (a) insolation and warming of the atmosphere; (b) absence of insolation and cooling of the atmosphere.
20.4	**Atmospheric Pressure**
20.4.2	Define 'atmospheric pressure'.
20.4.4	State the: (a) SI unit of pressure; (b) units of pressure commonly used in meteorology.
20.4.6	Explain the relationship between air temperature and pressure lapse rate.
20.4.8	State the average pressure lapse rate in the lower troposphere and explain how this rate changes at higher altitudes.

Sub Topic	Syllabus Item
20.4.10	State the basic airflow properties that apply to isobars, and explain the application of these properties in the interpretation of synoptic charts.
20.4.12	Define: (a) anticyclone (or “high”); (b) depression (or “low”); (c) ridge of high pressure; (d) trough of low pressure; (e) col.
20.4.14	With respect to pressure systems, describe high and low level: (a) convergence; (b) divergence.
20.4.16	Explain how subsidence and ascent of air influences the type of weather commonly associated with pressure systems.
20.4.18	Describe the circulation and speed of the wind commonly associated with: (a) anticyclones and ridges of high pressure; (b) depressions and troughs of low pressure; (c) cols.
20.4.20	Identify the general direction of movement of pressure systems in the mid latitudes of both hemispheres.
20.4.22	Define 'diurnal' and 'semi-diurnal' variations, and: (a) describe the semi-diurnal variation of pressure; (b) state the latitudes where the semi-diurnal variation of pressure has significance; (c) explain the phenomena often associated with a departure from the semi-diurnal variation of pressure in those latitudes.
20.4.24	Define ‘pressure gradient’.
20.4.26	Explain the: (a) causes of pressure gradient; (b) relationship between isobars and pressure gradient.
20.4.28	Describe the meaning and consequences of ‘steep’ and ‘shallow’ pressure gradients.
20.4.30	List the assumed conditions on which the International Standard Atmosphere (ISA) is based.
20.4.32	Explain the need for, and application of, the International Standard Atmosphere.
20.4.34	Determine the temperature and pressure lapse rates in the ISA.
20.4.36	Given an ISA related temperature at an altitude, convert this to °C ambient, and given an ambient temperature °C at an altitude, convert this to ISA temperature.
20.4.38	Explain why an altimeter requires a subscale adjustment.
20.4.40	Define: (a) Pressure altitude; (b) Density altitude; (c) Elevation;

Sub Topic	Syllabus Item
	(d) QNH;
	(e) QFE;
	(f) QNE;
	(g) FL.
20.4.42	Determine altimeter indications, and/or altitude of aircraft, when subscale settings are incorrect.
20.6	**Temperature and Heat Exchange Processes**
20.6.2	Identify the effect of changes in temperature on the volume and density of gases.
20.6.4	State the units of measurement of temperature.
20.6.6	State the usual height at which the surface air temperature is measured.
20.6.8	Explain the effect of emitting or receiving radiation on the temperature of a body or gas.
20.6.10	List and explain the factors that influence the amount of solar energy received by the earth.
20.6.12	Explain the relationship between solar radiation, terrestrial radiation and warming/cooling of the atmosphere.
20.6.14	Define ‘atmospheric window’.
20.6.16	Define ‘energy budget’.
20.6.18	Describe the process of conduction.
20.6.20	Describe the process of convection.
20.6.22	Define ‘sensible heat’.
20.6.24	Define ‘latent heat’.
20.6.26	Explain how the atmosphere is warmed through the processes of:
	(a) conduction;
	(b) convection;
	(c) latent heat.
20.6.28	Describe ‘diurnal variation of surface air temperature’.
20.6.30	Explain the effects of the following factors on 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.
20.6.32	Define ‘specific heat’.
20.6.34	Interpret schematic graphs that illustrate the diurnal variation of surface air temperature over a 24 hour period which reflects the factors listed:
	(a) over land, over oceans or over other large water areas;
	(b) differing cloud cover and;
	(c) differing wind conditions.
20.6.36	Describe the basic principles and methods through which heat transfer takes place

Sub Topic	Syllabus Item
	globally.
20.6.38	Describe the main characteristics of the following climates: (a) maritime; (b) continental.
20.8	**Atmospheric Moisture**
20.8.2	Define: (a) adiabatic process; (b) super saturation.
20.8.4	Describe and explain the condensation process and the main methods through which condensation occurs.
20.8.6	Explain what is meant by ‘partial pressure’ of a gas.
20.8.8	Explain what is meant by ‘saturation vapour pressure of moist air’.
20.8.10	Describe the effect of ice surfaces, and high atmospheric temperatures, on the saturation vapour pressure of moist air.
20.8.12	Describe how temperature, water content of air, the wind, and atmospheric pressure influence the rate of evaporation.
20.8.14	Explain the relationship between density, temperature and the volume of water.
20.8.16	Define what is meant by the terms: (a) absolute humidity; (b) humidity mixing ratio; (c) saturation mixing ratio; (d) relative humidity.
20.8.18	Describe the diurnal variation of relative humidity.
20.8.20	Define ‘dew point’.
20.8.22	Explain how water content and altitude influence the value of the dew point.
20.8.24	Describe the relationship between absolute humidity, air temperature, relative humidity and dew point.
20.8.26	Describe the effect of moisture content on the density of air.
20.10	**Wind**
20.10.2	State the four forces that have a fundamental influence on the wind velocity.
20.10.4	Explain the principle of Coriolis Effect on moving air.
20.10.6	State the: (a) variation of the magnitude of Coriolis force with latitude; (b) direction of Coriolis force relative to the flow of air.
20.10.8	Explain the effect of Coriolis force and pressure gradient on the movement of air relative to the isobars.
20.10.10	Describe the inter-relation between pressure gradient, Coriolis force and centrifugal force on the curvature of the isobars around high and low pressure systems in the Southern Hemisphere.
20.10.12	Define: (a) gradient wind;

Sub Topic	Syllabus Item
	(b) geostrophic wind.
20.10.14	Explain how stability, wind strength and surface roughness affect the friction layer near the earth's surface.
20.10.16	Describe the diurnal variation of the surface wind in the Southern Hemisphere.
20.10.18	Describe the change in wind velocity when climbing out of, or descending into, the friction layer.
20.10.20	State the usual height at which the surface wind is measured.
20.12	**Stability of Air**
20.12.2	Describe how stable and unstable air affect flying conditions.
20.12.4	State the two main factors that determine whether air will be stable or unstable.
20.12.6	Describe what is meant by ‘environment lapse rate (ELR)’.
20.12.8	Interpret appropriate graphs that: (a) identify steep and shallow ELRs; (b) identify and describe ‘inversions’ and ‘isothermal layers’.
20.12.10	Interpret graphs comparing the DALR against altitude and temperature, and identify the temperature changes in rising and descending parcels of unsaturated air.
20.12.12	Comparing ELR against DALR, explain how the stability or instability of rising and descending 'dry' air can be determined.
20.12.14	Explain why the SALR steepens with altitude.
20.12.16	Explain what is meant by: (a) ‘absolute stability’; (b) ‘absolute instability’; (c) ‘conditional stability (or instability)’.
20.12.18	Explain the effect of mixing of air and turbulence on the ELR.
20.12.20	Explain what is meant by ‘super adiabatic lapse rate’.
20.12.22	Given environment temperatures, dew points and mountain crest elevation, for forced ascent: (a) calculate the condensation level or dew point; (b) determine the stability of air; (c) determine the type of cloud, if formed; (d) determine the cloud top, if possible; (e) determine the cloud base and surface temperature on the lee side of mountain.
20.12.24	Given an ELR and dew point: (a) determine the convective condensation level; (b) calculate the required surface temperature to produce cumuliform cloud; (c) determine, if possible, cloud top height.
20.12.26	Describe: (a) convective stability; (b) diurnal variation of stability.
20.14	**Local winds – South Pacific Region**
20.14.2	Describe the sea breeze process, and describe the typical:

Sub Topic	Syllabus Item
	(a) effect on air temperature over the land;
	(b) effect on the pressure gradient;
	(c) associated wind shear problems;
	(d) associated turbulence;
	(e) associated precipitation.
20.14.4	Describe the pseudo sea breeze process.
20.14.6	Describe the land breeze process.
20.14.8	With regard to the land breeze process, explain the most likely season for the occurrence.
20.14.10	Describe the katabatic and anabatic wind processes.
20.14.12	Explain the factors that affect wavelength of mountain waves.
20.14.14	Explain the factors that affect amplitude of mountain waves.
20.14.16	Describe the:
	(a) action of rotor zones with mountain waves;
	(b) cloud formations often associated with mountain waves;
	(c) flight conditions associated with mountain waves.
20.14.18	Explain the rotor streaming process.
20.14.20	Describe the flight conditions associated with rotor streaming.
20.14.22	State the requirements for the formation of a Fohn wind.
20.14.24	Describe the flight conditions on the windward, over, and on the lee side of the mountain range when a Fohn wind is present.
20.18	**Cloud**
20.18.2	Describe the:
	(a) main causes which can produce rising air, and formation of cloud;
	(b) relationship between stability of air and cloud type.
20.18.4	List two processes that can provide/enhance buoyancy of air.
20.18.6	List the factors that determine the rate at which falling water drops evaporate below cloud, and describe the significance of each factor.
20.18.8	Describe the relationship between air temperature, relative humidity, dew point, the water content of cloud, and the associated cloud base.
20.18.10	List the vertical dimensions of the three main cloud layers in:
	(a) mid latitudes;
	(b) tropical latitudes.
20.18.12	Describe conditions to be expected with each type of cloud with respect to:
	(a) turbulence;
	(b) icing;
	(c) precipitation.
20.20	**Precipitation**
20.20.2	List the factors that affect the fall rate of water drops.
20.22	**Visibility**

Sub Topic	Syllabus Item
20.22.2	Describe the following factors affecting visibility range: (a) colour background; (b) white-out; (c) sunlight and moonlight.
20.22.4	Explain the factors involved in 'slant range' during the final stages of an approach.
20.22.6	Define runway visual range (RVR).
20.22.8	Explain the effect of altitude on visibility.
20.24	**Fog**
20.24.2	Differentiate between fog, mist and haze.
20.24.4	Describe the principle of formation, required meteorological conditions, factors affecting extent, timing, and dispersal of: (a) upslope fog; (b) cold and warm stream fog.
20.26	**Fronts and Depressions**
20.26.2	Describe and explain the likely weather conditions in Australasia during warm and cold airstream advection.
20.26.4	Explain the characteristics of: (a) mid-latitude depressions; (b) polar depressions.
20.26.6	Describe the: (a) cold, warm, stationary, occluded front; (b) wind and weather sequence associated with each type of front; (c) movement of fronts and pressure systems.
20.26.8	Describe the factors associated with: (a) orographic depressions; (b) the heat (or thermal) low.
20.28	**Thunderstorms**
20.28.2	Describe the: (a) three stages of thunderstorms; (b) regeneration of thunderstorms.
20.28.4	List the types of thunderstorm, and describe the: (a) characteristics and development of each type; (b) hazards associated with thunderstorms; (c) precautions that can be taken by pilots to avoid or lessen the effects of flying in the vicinity of thunderstorms.
20.28.6	Describe the processes involved in the formation of hail.
20.30	**Icing**
20.30.2	Explain the process of freezing and melting.
20.30.4	Define latent heat of fusion.
20.30.6	Describe the process involved in the formation of:

Sub Topic	Syllabus Item
	(a) clear (translucent or glaze) ice;
	(b) rime (opaque) ice;
	(c) hoar frost;
	(d) freezing rain.
20.30.8	Explain the factors, which influence the rate of ice accretion.
20.30.10	Explain the:
	(a) likelihood of ice accretion in the 10 main cloud types;
	(b) type of ice to be expected in these cloud types;
	(c) altitudes relative to the freezing level where rime or clear ice can be expected in the cloud types.
20.30.12	List the intensity classifications of icing and describe their effect on aircraft.
20.32	**Turbulence**
20.32.2	Define ‘turbulence’.
20.32.4	Describe the cause(s), factors involved and techniques commonly used to avoid or minimise the effects of:
	(a) thermal turbulence;
	(b) mechanical turbulence – small scale and large scale;
	(c) wind shear turbulence;
	(d) wake turbulence.
20.32.6	Describe the characteristics of:
	(a) light turbulence;
	(b) moderate turbulence;
	(c) severe turbulence.
	Tropical Meteorology
20.38	**Tropical Meteorology**
20.38.2	State the approximate latitude limits applicable to tropical meteorology.
20.38.4	In broad terms, describe the Hadley cell.
20.38.6	Explain what is meant by:
	(a) horse latitudes;
	(b) doldrums.
20.38.8	Describe the equatorial trough and the intertropical convergence zone (ITCZ).
20.38.10	Describe the:
	(a) seasonal location of the equatorial trough and ITCZ;
	(b) typical low and mid level weather in an active and inactive ITCZ.
20.38.12	Explain the origin, common location and associated weather of the South Pacific Convergence Zone (SPCZ).
20.38.14	With regard to the trade winds, describe the:
	(a) origin and mechanics of the trade winds;
	(b) approximate latitudinal and vertical limits;
	(c) seasonal location and direction;

Sub Topic	Syllabus Item
	(d) commonly associated weather;
	(e) winds and weather usually experienced above the trade winds;
	(f) topographical influences on the trade winds.
20.38.16	Define ‘monsoon’.
20.38.18	With regard to wet monsoons, describe the mechanics involved.
20.38.20	State the season during which the Australian monsoon is generally present.
20.38.22	List the requirements for the formation and development of tropical cyclones.
20.38.24	With regard to tropical cyclones, describe the horizontal and vertical extents, pressure and wind velocity tendencies, and other associated factors during the:
	(a) formative stage;
	(b) immature stage;
	(c) mature stage;
	(d) decaying stage.
20.38.26	Describe the weather conditions associated with tropical cyclones.
20.38.28	Explain the factors causing:
	(a) El Nino events;
	(b) La Nina events.
20.38.30	Describe how the El Nino and La Nina events influence the weather in New Zealand.
	Global Meteorology
20.40	**The General Circulation**
20.40.2	Explain what is meant by “The General Circulation”.
20.40.4	State the common locations in the southwest Pacific Ocean where ‘blocking anticyclones’ tend to form.
20.40.6	Describe the characteristics of a blocking anticyclone.
20.40.8	Describe the weather in the east and west of New Zealand when a blocking anticyclone has formed to the immediate east of the country.
20.40.10	Describe what is meant by ‘streamline analysis’.
20.40.12	Explain how isotachs and streamlines can be used to determine wind velocity.
20.40.14	Describe how areas of high and low pressure, convergence/divergence, and cols are depicted on streamline analysis charts.
	Hazardous Meteorological Conditions
20.42	**Hazardous meteorological conditions**
20.42.2	Describe the effects on climbing and descending flight paths when low-level wind shear is experienced.
20.42.4	Explain the mechanics of a downburst.
20.42.6	Explain the mechanics of a microburst.
20.42.8	With regard to the rate of ice accretion, explain the effect of:
	(a) airspeed (including helicopter rotor rpm);
	(b) shape of aircraft components.
20.42.10	Explain the operational significance of:
	(a) areas affected by volcanic ash;

Sub Topic	Syllabus Item
	(b) wet and/or contaminated runways including aquaplaning.
	Meteorological Services to Aviation
20.46	**Regional meteorological services, reports and forecasts**
20.46.2	Assess and interpret information presented on mean sea level analysis and prognosis weather charts covering the Southwest Pacific region.
20.46.4	Describe the general principles of operation of automatic weather stations and associated equipment including the modern visibility sensor and laser ceilometers and their limitations.
20.46.6	With respect to NZ domestic and regional IFR and VFR operations, interpret, understand and assess information of all descriptions contained in: (a) area forecast (ARFOR); (b) route forecast (ROFOR); (c) meteorological reports (METAR/SPECI/ METAR AUTO); (d) trend forecasts (TREND); (e) aerodrome forecasts (TAF); (f) SIGMET; (g) automatic terminal information service (ATIS); (h) aerodrome and weather information broadcast (AWIB); (i) basic weather reports (BWR); (j) Routine Broadcast of Meteorological Information For Aircraft In Flight (VOLMET); (k) Volcanic Ash Advisory (VAA); (l) pilot reports; (m) Medium SIGWX chart; (n) Satellite imagery; (o) Radar imagery.