Private Pilot Licence Examinations – 082 Principles of Flight Helicopter

		Aeroplane		Helicopter	
Syllabus Reference	**Syllabus details & Associated Learning Objective**	**PPL**	**Bridge Course**	**PPL**	**Bridge Course**
082.00.00.00	**PRINCIPLES OF FLIGHT: HELICOPTER**				
082.01.01.00	**Subsonic aerodynamics**				
082.01.01.01	Basic concepts, laws and definitions			x	x
082.01.01.02	Conversion of units			x	x
082.01.01.03	Definitions and basic concepts about air:			x	x
	(a) the atmosphere and International Standard Atmosphere;			x	x
	(b) density;			x	x
	(c) influence of pressure and temperature on density.			x	x
082.01.01.04	Newton's laws:			x	x
	(a) Newton's second law: Momentum equation;			x	x
	(b) Newton's third law: action and reaction.			x	x
082.01.01.05	Basic concepts about airflow:			x	x
	(a) steady airflow and unsteady airflow;			x	x
	(b) Bernoulli's equation;			x	x
	(c) static pressure, dynamic pressure, total pressure and stagnation point;			x	x
	(d) TAS and IAS;			x	x
	(e) two-dimensional airflow and three-dimensional airflow;			x	x
	(f) viscosity and boundary layer.			x	x
082.01.01.06	**Two-dimensional airflow**			x	x
082.01.01.07	Aerofoil section geometry:			x	x
	(a) aerofoil section;			x	x
	(b) chord line, thickness and thickness to chord ratio of a section;			x	x
	(c) camber line and camber;			x	x
	(d) symmetrical and asymmetrical aerofoils sections.			x	x
082.01.01.08	Aerodynamic forces on aerofoil elements:			x	x
	(a) angle of attack;			x	x
	(b) pressure distribution;			x	x
	(c) lift and lift coefficient			x	x
	(d) relation lift coefficient: angle of attack;			x	x
	(e) profile drag and drag coefficient;			x	x
	(f) relation drag coefficient: angle of attack;			x	x
	(g) resulting force, centre of pressure and pitching moment.			x	x
082.01.01.09	Stall:			x	x
	(a) boundary layer and reasons for stalling;			x	x
	(b) variation of lift and drag as a function of angle of attack;			x	x
	(c) displacement of the centre of pressure and pitching moment.			x	x
082.01.01.10	Disturbances due to profile contamination:			x	x

	(a) ice contamination;			x	x
	(b) ice on the surface (frost, snow and clear ice).			x	x
082.01.01.11	The three-dimensional airflow round a wing and a fuselage			x	x
082.01.01.12	The wing:			x	x
	(a) planform, rectangular and tapered wings;			x	x
	(b) wing twist.			x	x
082.01.01.13	Airflow pattern and influence on lift:			x	x
	(a) span wise flow on upper and lower surface;			x	x
	(b) tip vortices;			x	x
	(c) span-wise lift distribution.			x	x
082.01.01.14	Induced drag: causes and vortices			x	x
082.01.01.15	The airflow round a fuselage:			x	x
	(a) components of a fuselage;			x	x
	(b) parasite drag;			x	x
	(c) variation with speed.			x	x
082.02.01.00	**Transonic aerodynamics and compressibility effects**				
082.02.01.01	Airflow velocities			x	x
082.02.01.02	Airflow speeds:			x	x
	(a) speed of sound;			x	x
	(b) subsonic, high subsonic and supersonic flows.			x	x
082.02.01.03	Shock waves:			x	x
	(a) compressibility and shock waves;			x	x
	(b) the reasons for their formation at upstream high subsonic airflow;			x	x
	(c) their effect on lift and drag.			x	x
082.02.01.04	Influence of wing planform: sweep-angle			x	x
082.03.01.00	**Rotorcraft types**			x	x
082.03.01.01	Rotorcraft			x	x
082.03.01.02	Rotorcraft types:			x	x
	(a) autogyro;			x	x
	(b) helicopter.			x	x
082.03.01.03	Helicopters			x	x
082.03.01.04	Helicopters configurations: the single main rotor helicopter			x	x
082.03.01.05	The helicopter, characteristics and associated terminology:			x	x
	(a) general lay-out, fuselage, engine and gearbox;			x	x
	(b) tail rotor, fenestron and NOTAR;			x	x
	(c) engines (reciprocating and turbo shaft engines);			x	x
	(d) power transmission;			x	x
	(e) rotor shaft axis, rotor hub and rotor blades;			x	x
	(f) rotor disc and rotor disc area;			x	x
	(g) teetering rotor (two blades) and rotors with more than two blades;			x	x
	(h) skids and wheels;			x	x
	(i) helicopter axes and fuselage centre line;			x	x
	(j) roll axis, pitch axis and normal or yaw axis;			x	x
	(k) gross mass, gross weight and disc loading.			x	x
082.04.01.00	**Main rotor aerodynamics**			x	x
082.04.01.01	Hover flight outside ground effect			x	x
082.04.01.02	Airflow through the rotor discs and round the blades:			x	x
	(a) circumferential velocity of the blade sections;			x	x
	(b) induced airflow, through the disc and downstream;			x	x

	(c) downward fuselage drag;			x	x
	(d) equilibrium of rotor thrust, weight and fuselage drag;			x	x
	(e) rotor disc induced power;			x	x
	(f) relative airflow to the blade;			x	x
	(g) pitch angle and angle of attack of a blade section;			x	x
	(h) lift and profile drag on the blade element;			x	x
	(i) resulting lift and thrust on the blade and rotor thrust;			x	x
	(j) collective pitch angle changes and necessity of blade feathering;			x	x
	(k) required total main rotor-torque and rotor-power;			x	x
	(l) influence of the air density.			x	x
082.04.01.03	Anti-torque force and tail rotor:			x	x
	(a) force of tail rotor as a function of main rotor-torque;			x	x
	(b) anti-torque rotor power;			x	x
	(c) necessity of blade feathering of tail rotor blades and yaw pedals.			x	x
082.04.01.04	Maximum hover altitude OGE:			x	x
	(a) total power required and power available;			x	x
	(b) maximum hover altitude as a function of pressure altitude and OAT.			x	x
082.04.01.05	Vertical climb			x	x
082.04.01.06	Relative airflow and angles of attack:			x	x
	(a) climb velocity VC, induced and relative velocity and angle of attack;			x	x
	(b) collective pitch angle and blade feathering.			x	x
082.04.01.07	Power and vertical speed:			x	x
	(a) induced power, climb power and profile power;				
	(b) total main rotor power and main rotor torque;			x	x
	(c) tail rotor power;			x	x
	(d) total power requirement in vertical flight.			x	x
082.04.01.08	Forward flight			x	x
082.04.01.09	Airflow and forces in uniform inflow distribution:			x	x
	(a) assumption of uniform inflow distribution on rotor disc;			x	x
	(b) advancing blade (90°) and retreating blade (270°);			x	x
	(c) airflow velocity relative to the blade sections, area of reverse flow;			x	x
	(d) lift on the advancing and retreating blades at constant pitch angles;			x	x
	(e) necessity of cyclic pitch changes;			x	x
	(f) compressibility effects on the advancing blade tip and speed limitations;			x	x
	(g) high angle of attack on the retreating blade, blade stall and speed limitations;			x	x
	(h) thrust on rotor disc and tilt of thrust vector;			x	x
	(i) vertical component of the thrust vector and gross weight equilibrium;			x	x

	(j) horizontal component of the thrust vector and drag equilibrium.			x	x
082.04.01.10	The flare (power flight):			x	x
	(a) thrust reversal and increase in rotor thrust;			x	x
	(b) increase of rotor RPM on non governed rotor.			x	x
082.04.01.11	Power and maximum speed:			x	x
	(a) induced power as a function of helicopter speed;			x	x
	(b) rotor profile power as a function of helicopter speed;			x	x
	(c) fuselage drag and parasite power as a function of forward speed;			x	x
	(d) tail rotor power and power ancillary equipment;			x	x
	(e) total power requirement as a function of forward speed;			x	x
	(f) influence of helicopter mass, air density and drag of additional external equipment;			x	x
	(g) translational lift and influence on power required.			x	x
082.04.01.12	Hover and forward flight in ground effect			x	x
082.04.01.13	Airflow in ground effect and downwash: rotor power decrease as a function of rotor height above the ground at constant helicopter mass			x	x
082.04.01.14	Vertical descent			x	x
082.04.01.16	Vertical descent, power on:			x	x
	(a) airflow through the rotor, low and moderate descent speeds;			x	x
	(b) vortex ring state, settling with power and consequences.			x	x
082.04.01.17	Autorotation:			x	x
	(a) collective lever position after failure;			x	x
	(b) up flow through the rotor, auto-rotation and anti-autorotation rings;			x	x
	(c) tail rotor thrust and yaw control;			x	x
	(d) control of rotor RPM with collective lever;			x	x
	(e) landing after increase of rotor thrust by pulling collective and reduction in vertical speed.			x	x
082.04.01.18	Forward flight: Autorotation			x	x
082.04.01.19	Airflow through the rotor disc:			x	x
	(a) descent speed and up flow through the disc;			x	x
	(b) the flare, increase in rotor thrust, reduction of vertical speed and ground speed.			x	x
082.04.01.20	Flight and landing:			x	x
	(a) turning;			x	x
	(b) flare;			x	x
	(c) autorotative landing;			x	x
	(d) height or velocity avoidance graph and dead man's curve.			x	x
082.05.01.00	**Main rotor mechanics**			x	x
082.05.01.01	Flapping of the blade in hover			x	x
082.05.01.02	Forces and stresses on the blade:			x	x
	(a) centrifugal force on the blade and attachments;			x	x
	(b) limits of rotor RPM;			x	x

	(c) lift on the blade and bending stresses on a rigid attachment;			x	x
	(d) the flapping hinge of the articulated rotor and flapping hinge offset;			x	x
	(e) the flapping of the hinge less rotor and flexible element.			x	x
082.05.01.03	Coning angle in hover:			x	x
	(a) lift and centrifugal force in hover and blade weight negligible			x	x
	(b) flapping, tip path plane and disc area.			x	x
082.05.01.04	Flapping angles of the blade in forward flight			x	x
082.05.01.05	Forces on the blade in forward flight without cyclic feathering:			x	x
	(a) aerodynamic forces on the advancing and retreating blades without cyclic feathering;			x	x
	(b) periodic forces and stresses, fatigue and flapping hinge;			x	x
	(c) phase lag between the force and the flapping angle (about 90°);			x	x
	(d) flapping motion of the hinged blades and tilting of the cone and flap back of rotor;			x	x
	(e) rotor disc attitude and thrust vector tilt.			x	x
082.05.01.06	Cyclic pitch (feathering) in helicopter mode, forward flight:			x	x
	(a) necessity of forward rotor disc tilt and thrust vector tilt;			x	x
	(b) flapping and tip path plane, virtual rotation axis or no flapping axis and plane of rotation;			x	x
	(c) shaft axis and hub plane;			x	x
	(d) cyclic pitch change (feathering) and rotor thrust vector tilt;			x	x
	(e) collective pitch change, collective lever, swash plate, pitch link and pitch horn;			x	x
	(f) cyclic stick, rotating swash plate and pitch link movement and phase angle.			x	x
082.05.01.07	Blade lag motion			x	x
082.05.01.08	Forces on the blade in the disc plane (tip path plane) in forward flight:			x	x
	(a) forces due to the Coriolis effect because of the flapping;			x	x
	(b) alternating stresses and the need of the drag or lag hinge.			x	x
082.05.01.09	The drag or lag hinge:			x	x
	(a) the drag hinge in the fully articulated rotor;			x	x
	(b) the lag flexure in the hinge less rotor;			x	x
	(c) drag dampers.			x	x
082.05.01.10	Ground resonance:			x	x
	(a) blade lag motion and movement of the centre of gravity of the blades and the rotor;			x	x
	(b) oscillating force on the fuselage;			x	x
	(c) fuselage, undercarriage and resonance.			x	x
082.05.01.11	Rotor systems			x	x

082.05.01.12	See-saw or teetering rotor			x	x
082.05.01.13	Fully articulated rotor:			x	x
	(a) three hinges arrangement;			x	x
	(b) bearings and elastomeric hinges.			x	x
082.05.01.14	Hinge less rotor and bearing less rotor			x	x
082.05.01.15	Blade sailing:			x	x
	(a) low rotor RPM and effect of adverse wind;			x	x
	(b) minimising the danger;			x	x
	(c) droop stops.			x	x
082.05.01.16	Vibrations due to main rotor:			x	x
	(a) origins of the vibrations: in plane and vertical;			x	x
	(b) blade tracking and balancing.			x	x
082.06.01.00	**Tail rotors**			x	x
082.06.01.01	Conventional tail rotor			x	x
082.06.01.02	Rotor description:			x	x
	(a) two-blades tail rotors with teetering hinge;			x	x
	(b) rotors with more than two blades;			x	x
	(c) feathering bearings and flapping hinges;			x	x
	(d) dangers to people and to the tail rotor, rotor height and safety.			x	x
082.06.01.03	Aerodynamics:			x	x
	(a) induced airflow and tail rotor thrust;			x	x
	(b) thrust control by feathering, tail rotor drift and roll;			x	x
	(c) effect of tail rotor failure and vortex ring.			x	x
082.06.01.04	The fenestron: technical lay-out			x	x
082.06.01.05	The NOTAR: technical lay-out			x	x
082.06.01.06	Vibrations: high frequency vibrations due to the tail rotors			x	x
082.07.00.00	**Equilibrium, stability and control**			x	x
082.07.01.00	Equilibrium and helicopter attitudes			x	x
082.07.01.01	Hover:			x	x
	(a) forces and equilibrium conditions;			x	x
	(b) helicopter pitching moment and pitch angle;			x	x
	(c) helicopter rolling moment and roll angle.			x	x
082.07.01.02	Forward flight:			x	x
	(a) forces and equilibrium conditions;			x	x
	(b) helicopter moments and angles;			x	x
	(c) effect of speed on fuselage attitude.			x	x
082.07.01.03	Control			x	x
082.07.01.04	Control power			x	x
	(a) fully articulated rotor;			x	x
	(b) hinge less rotor;			x	x
	(c) teetering rotor.			x	x
082.07.01.05	Static and dynamic roll over			x	x
082.08.01.00	**Helicopter performances**			x	x
082.08.01.01	Engine performances			x	x
082.08.01.02	Piston engines:			x	x
	(a) power available;			x	x
	(b) effects of density altitude.			x	x
082.08.01.03	Turbine engines:			x	x
	(a) power available;			x	x

	(b) effects of ambient pressure and temperature.			x	x
082.08.01.04	Helicopter performances			x	x
082.08.01.05	Hover and vertical flight:			x	x
	(a) power required and power available;			x	x
	(b) OGE and IGE maximum hover height;			x	x
	(c) influence of AUM, pressure, temperature and density.			x	x
082.08.01.06	Forward flight:			x	x
	(a) maximum speed;			x	x
	(b) maximum rate of climb speed;			x	x
	(c) maximum angle of climb speed;			x	x
	(d) range and endurance;			x	x
	(e) influence of AUM, pressure, temperature and density.			x	x
082.08.01.07	Manoeuvring:			x	x
	(a) load factor;			x	x
	(b) bank angle and number of g's;			x	x
	(c) manoeuvring limit load factor.			x	x
082.08.01.08	Special conditions:			x	x
	(a) operating with limited power;			x	x
	(b) over pitch and over torque.			x	x