

AIRLINE TRANSPORT PILOTS LICENCE
082 00 00 00 –Helicopter Principles of Flight

JAR-FCL REF

LEARNING OBJECTIVES

082 01 00 00	SUBSONIC AERODYNAMICS
082 01 01 00	Basic Laws and definitions Describe Newton’s First, Second, & Third Law of Motion
082 01 01 01	Components of Aircraft Describe - Wings / Fuselage / Tailplane / Fin Engine / Undercarriage Describe briefly the controls and their function: Elevator / Ailerons / Rudder / Flaps / Trim tabs
082 01 01 02	Aircraft Configuration Locate Aircraft parts and controls
082 01 01 03	Units of Measurement List the S.I. units for measurement, acceleration, velocity, density, temperature, pressure, force, wing loading, and power. Explain Density. List the atmospheric properties that affect air density Explain how temperature and pressure changes affect density Describe the resolution of a force Show graphical resolution and explain that this will be the common way to show forces in principles of flight
082 01 01 04	Terms used to describe aerodynamic phenomena Define Streamline flow (see 08201 02 03) Define laminar flow Define turbulent flow
082 01 01 05	Reference speeds State: - IAS / V_y / V_{NE} / V_{NO}
082 01 01 06	Abbreviations List: - Cl / Cd / IAS / TAS
082 01 02 00	Derivation of lift Briefly describe lift
082 01 02 01	Equation of continuity (or conservation of mass)
082 01 02 02	State Bernoulli’s theorem Define total pressure Apply the theorem to a Venturi Apply the theorem for a given speed and altitude and how the IAS is acquired from Pitot total and static pressure
082 01 02 03	Define streamline flow
082 01 02 04	Define angle of attack (see 082 01 06 01)

082 01 02 05	Show how it varies with aircraft attitude Pressure distribution about a wing (transverse and longitudinal) Show proportions above and below the wing
082 01 02 06	Centre of pressure Define and show its approximate position
082 01 02 07	Aerofoil shape (plan and section) and its effect on lift Describe different sectional shapes: - Symmetrical / Asymmetrical State the different applications
082 01 02 08	Describe: span, chord, mean chord, wing area, and aspect ratio Lift formula Define the formula Describe how lift is generated Describe with a simple graph the variation of lift with angle of attack Define the critical angle
082 01 02 09	Lift/Drag ratio. Describe the lift/drag ratio with the aid of a simple graph against Angle of attack Show the difference between symmetrical and positively cambered aerofoils. State the use for resolving the forces to be overcome in flight
082 01 03 00	Drag Define drag
082 01 03 01	Profile drag (Zero lift Drag) Define profile drag as the sum of Surface Friction drag and Form drag Describe surface friction drag (see 082 01 06 02) Describe the boundary layer Show: Laminar flow / Turbulent flow / Transition point / Separation point Describe Form Drag Show differences between drag on a flat plate perpendicular to the air velocity and a streamlined shape Show the use of a coefficient to calculate the drag Describe interference drag Describe methods of minimising profile drag
082 01 03 02	Induced Drag (Lift dependant drag) Describe the causes Describe the effect of vortices Describe how it varies with speed Describe design factors to reduce it - winglets - wing span loading - wing twist - camber

082 01 03 03	- aspect ratio Combined effect of Profile and Induced Drag Describe the total resultant effect with the aid of a simple graph
082 01 04 00	Forces on an aircraft Describe the forces and distribution:
	- Lift / Weight / Thrust / Drag
082 01 04 01	Describe the forces in straight level flight Describe the balance of couples:
	-Lift/weight
	-Thrust/drag
082 01 04 02	Describe the couples and their pitching moments
082 01 04 03	Describe the necessity to achieve balance Methods of achieving balance:
	- matching couples
	- use of tailplane
	- variations with speed in level flight
	- effect of weight on level flight
	- effect of altitude on level flight
082 01 05 00	Stability
081 01 05 01	Axes of rotation Describe the axes Describe the movement around an axis and state the terminology
	- lateral stability (pitch)
	- longitudinal stability (roll)
	- directional stability
082 01 05 02	Static stability Define static stability Explain why static stability is desirable
082 01 05 03	Dynamic stability Describe dynamic stability Show the effect of positive, neutral, and negative stability on an airplane
082 01 05 04	Show briefly the effects of design features on stability:
	- Tailplanes
	- Dihedral / anhedral / sweepback
	- Wing position-high/low
	- Fuselage and fin
082 01 05 05	Interaction between stability about different axes Show the effects in 082 01 05 03 operating in different planes
082 01 05 06	Effect of altitude/speed on stability Describe the reduction in stability with altitude and the effect of speed on stability
082 01 05 07	Roll and Yaw dampers Briefly explain the uses of roll and yaw dampers

082 01 06 00	The Stall
082 01 06 01	Angle of Attack Show that an aerofoil will stall at the Critical angle Show how the co-efficient of lift decrease dramatically above the Critical angle
082 01 06 02	Boundary layer and reasons for stalling Describe the flow in the boundary layer (see 082 01 03 01) Describe the Adverse Pressure Gradient Describe the separation point movement Describe the result of the stall
082 01 06 03	Variation of lift and drag at the stall Show how different wing shapes affect the stall Discuss the stalling speed change with changes of: <ul style="list-style-type: none"> - altitude - weight
082 01 06 04	Movement of the centre of pressure Describe the movement of the centre of pressure with angle of attack increase Describe the movement at the stall
082 01 07 00	Transonic effect on a blade Define speed of sound Define Mach number as a function of TAS and speed of sound Compressibility State that compressibility means that density can change along a streamline State that compressibility is related to the Mach number
082 01 07 01	Shock waves (see 082 02 11 05) Explain the reasons for the formation at subsonic speed Explain the effect on control surfaces Explain the effect on rotor blades and the control of a helicopter
082 01 08 00	Limitation Discuss basic aeroplane limitations <ul style="list-style-type: none"> - stall speed of a fixed wing aircraft - V_{NE}
082 01 08 01	Discuss: <ul style="list-style-type: none"> - manoeuvring - wing loading - effects of altitude - effects of crosswinds and gusts
082 01 09 00	Performance degradation Discuss with regard to fixed and rotary wing.

	Describe erosion effects (see 082 02 07 05) from soil / sand / salt
082 01 09 01	Adverse effect on performance due to profile contamination - Icing : shape, weight, and engine intake - Rain: erosion of leading edge Explain that airflow may be disrupted - parasite drag effects - interference drag effects
082 02 00 00	HELICOPTER AERODYNAMICS
082 02 01 00	The Helicopter and Associated Terminology
082 02 01 01	Comparison with fixed-wing Briefly explain the functioning of an autogyro and the main differences from a helicopter Explain that the helicopter rotor supplies both the lift and thrust
082 02 01 02	Define : Plane of Rotation parallel to the tip path plane
082 02 01 03	Define: Axis of Rotation (Virtual axis of Rotation)
082 02 01 04	Define: Rotor Shaft
082 02 01 05	Describe the Tip Path Plane
082 01 01 06	Describe the Rotor Disc and the direction of rotation from above.
082 02 01 07	Describe Disc Loading. Show a simple calculation
082 02 01 08	Describe Blade Loading. Show differences between disc/blade/wing loading and discuss the relevant stresses involved. Describe Solidity
082 02 02 00	The Forces Diagram and Associated Terminology Describe the basic aerodynamic forces on an aerofoil (rotor blade) List : Relative Airflow / Chord line / Lift / Drag / Aerodynamic force (or total reaction) / Centre of pressure
082 02 02 01	Define: Blade Pitch Angle (BPA) Discuss the differences between fixed angle of incidence (aeroplanes) and the variable BPA(helicopters)
082 02 02 02	Rotational Airflow Describe the blade movement in the plane of rotation Discuss variations in revolutions per minute (RPM) by different types of helicopter Briefly mention tip speed limitations (ref. later to 082 02 11 05)
082 02 02 03	Discuss rotational speed (V_r) variations from root to tip Induced Airflow Describe downwash as a result of producing aerodynamic lift. Show the result of a succession of blades producing a continual downwash column (annotated V_i)
082 02 02 04	Relative airflow(RAF) Describe how the relative airvelocity is the result of the rotational velocity and the induced velocity

	<p>Show vectorially: V_r in the plane of rotation V_i at 90° to the Plane of rotation Resultant velocity vector</p>
082 02 02 05	<p>Angle of Attack Define the angle of attack</p>
082 02 02 06	<p>Describe the relationship of angle of attack and the blade pitch angle Lift State lift as a component of the aerodynamic force (or total reaction) and as a useful fixed-wing force</p>
082 02 02 07	<p>Drag State drag as a component of the aerodynamic force (or total reaction)</p>
082 02 02 08	<p>Total Reaction or aerodynamic force Show that lift and drag are not practical forces as they are for fixed- wing aircraft State that a aerodynamic force vector may be resolved as required.</p>
082 02 02 09	<p>Rotor Thrust and Rotor Drag</p>
082 02 02 10	<p>Resolve aerodynamic force (or total reaction) to give useful forces: the thrust : parallel to the virtual axis of rotation, the H drag: in the plane of rotation (H drag or Rotor Drag). Show the sum of the thrust from all the blades through the hub centre : Rotor thrust (or Total Rotor Thrust , TRT) Show that Rotor Thrust provides the force to overcome weight in straight level flight.</p>
082 02 02 11	<p>Torque / Engine power Describe torque through the rotor shaft Show that torque is used to counteract rotor drag.</p>
082 02 02 12	<p>Weight Describe weight as mass x gravity Show as represented by a single vector. Briefly discuss the centre of gravity. Show that the helicopter is supported from the rotor head.</p>
082 02 03 00	<p>Distribution of Rotor Thrust Along the Blade Span Show variation of rotational speed (V_r) at sections along the span Show resultant variation of thrust at sections along the span Describe the resulting bending stresses and where they act Describe methods of smoothing thrust at sections along the span of the blade by:</p>
082 02 03 01	<p>Washout</p>
082 02 03 02	<p>Taper</p>
082 02 03 03	<p>Coning Angle Describe Coning Angle Show how it varies with change in blade pitch angle</p>
082 02 03 04	<p>Centrifugal Force Show how it varies with rotor RPM and the effect on coning angle</p>

- 082 032 03 05 Describe the relationship between rotor thrust and rotor RPM
Describe teetering rotors and built-in coning angles.
Limits of Rotor RPM
Describe reasons for upper limits
Describe reasons for lower limits
Describe effect of
 reduced rotor RPM
 reduced disc area
 overpitching
 recovery from overpitching
- 082 02 03 06 Centrifugal Turning moments
Describe: Theory
 Resolution of the centrifugal force
 Moments causing feathering
Methods of counteracting by:
 Hydraulics
 Bias springs
 Balance weights
- 082 02 04 00 Helicopter Controls
State the three main controls
 Collective – vertical movement
 Cyclic – horizontal movement
 Yaw pedals – yawing movement
- 082 02 04 01 Collective lever
Describe operation through:
 Swash plate
 Pitch operating arms or pitch-link
 Pitch horns
Effect of collective pitch change on:
 Rotor thrust
 Rotor drag
 Engine torque (correlator)
- 082 02 04 02 Describe rotor RPM control through throttle twist grip or governor
Cyclic Stick
Describe: Variations of cyclic pitch through 360° cycle
 Changes in disc tilt
 Changes in rotor thrust tilt
 Resultant horizontal thrust component
- 082 02 04 03 Yaw Pedals
Describe the basic anti torque operation
State that blade pitch changes collectively
Restate the theory of moments to balance the torque forces
State the four main functions:
 Balance fuselage torque reaction
 Alter heading in the hover

Maintain balanced forward flight

Stop fuselage rotating in power off (autorotative) flight

Describe Tail Rotor Drift

Describe the residual force from anti torque correction

State the direction depends on the direction of rotation of the main rotor blades as viewed from above (for examination purposes assume the main rotor blades rotate anticlockwise when viewed from above unless otherwise specified).

Describe method for correcting tail rotor drift:

Cyclic movement

Rigging of controls

Rotor shaft tilt

Mixing of controls

Tail Rotor Roll

Describe couple effect of horizontal component of total rotor thrust / tail rotor thrust

Describe correction

Describe resultant attitude

Describe effects of centre of gravity changes.

Describe attitude changes during transition to forward flight.

Explain that this is only one of several factors, which occur simultaneously during the transition to forward flight.

Fenestron Tail. Describe the construction

Compare performance with conventional tail rotor.

List advantages/ disadvantages

Discuss the safety aspects

NOTAR Describe the operation and the coanda effect.

List advantages/ disadvantages

Discus the safety aspects

Other forms of anti torque systems

Tandem rotors. Describe construction

Explain differential control of yaw system

Co – axial Rotors. Briefly describe the operation

State the suitability for specific operations

082 02 05 00

Rotor Blade Freedom of Movement

082 02 05 01

Feathering

Define feathering and the axis of operation

Describe the feathering hinge

Show the ability to change the blade pitch angle (BPA)

082 02 05 02

Flapping

Define flapping

Describe the flapping hinge

Show the alleviation of bending stress on an articulated rotor head and a teetering rotor head

	<p>Show that flapping following lever movement is usually referred to as coning</p> <p>Show that movement of the C of G position will cause flapping</p>
082 02 05 03	<p>Dragging</p> <p>Describe the drag hinge and the plane of movement</p> <p>Describe the drag damper and its function</p> <p>Explain the terms “ lead / lag</p> <p>Describe periodic drag changes (further notes 082 02 11 03)</p> <p>Describe the effect of movement of blade C of G relative to the hub/shaft axis (conservation of angular momentum/coriolis effect)</p> <p>Explain what happens when blades flap up /down relative to the hub</p> <p>Describe Hookes Joint Effect</p> <p>Show the result of these effects on underslung teetering rotors</p>
082 02 06 00	<p>Phase Lag</p> <p>Describe phase lag and state that it is the aerodynamic reaction to a control input.</p> <p>Describe Advance angle and show that it is a partial/full mechanical correction for phase lag</p>
082 02 06 01	Describe the Control Orbit
082 02 06 02	Describe the pitch operating arm movement
082 02 06 03	Describe the angular change of the pitch application
082 02 06 04	Describe the resultant angular flapping
082 02 06 05	Describe the resultant change in disc attitude
082 02 06 06	Define phase lag
082 02 06 07	Define advance angle
082 02 07 00	Vertical flight
082 02 07 01	Describe and show vectorially the movement of the helicopter from the ground to the free air hover
082 02 07 02	<p>Describe the entry into a vertical climb</p> <p>Describe the change in relative airflow</p> <p>Describe the helicopter in a steady climb</p>
082 02 07 03	Describe the steady state descent
082 02 07 04	Describe the hover outside ground effect (OGE)
082 02 07 05	<p>Describe Ground Effect and the reduction in induced velocity</p> <p>Show the comparison between IGE an OGE</p>
082 02 07 06	<p>Show the factors affecting ground effect:</p> <p>rough ground / long grass / water / slope / wind speed</p> <p>Describe the effect of recirculation on the induced flow</p> <p>Describe areas likely to cause recirculation:</p> <p>Long grass / Close to buildings / Depressions in the ground</p>
082 02 07 08	<p>Dynamic Rollover</p> <p>Describe the difference between static and dynamic rollover</p> <p>Describe angular momentum</p> <p>Show the development of the rollover</p>

	State the forces in action
	Discuss the physical limits of the controls
	State the recovery actions
	Describe the technique to initially avoid rollover
	Discuss contributory conditions:
	Type of helicopter / Surface / Wind direction
082 02 08 00	Forces in balance
082 02 08 01	At the hover.
	Relationship of rotor thrust/weight
	Tail rotor position
	Effect of C of G position on hover attitude in pitch and roll
082 02 08 02	In forward flight
	Disc tilt to provide horizontal thrust
	Pitching moments during acceleration
	Steady speed forces in level straight flight (vertical component of total rotor thrust, weight, horizontal component of total rotor thrust, drag)
	Effect of horizontal stabilizer
082 02 08 03	Describe the effect of C of G position on forward flight
082 02 08 04	Influence of main rotor shaft tilt:
	In forward flight
	In the hover
082 02 09 00	Translational Lift
	Describe translational lift
	State the approximate speed at which it becomes effective
082 02 09 01	Describe the effect of horizontal flow on the induced flow
	Describe the resultant increase in rotor thrust and the movement of the total reaction
	Describe the induced flow velocity and horizontal flow velocity relationship
	Describe the 90° component of horizontal flow
082 02 09 02	With a simple diagram show the components of horizontal flow and the total flow through the disc
082 02 09 03	Show the relationship between the pitch angle and the angle of attack at various speeds
082 02 10 00	Power requirements
082 02 10 01	Define rotor profile power
	Show how it will vary with altitude
082 02 10 02	Power absorption – tail rotor and ancillary equipment
	Show the variations in tail rotor power absorption
082 02 10 03	Rotor profile power variation with forward speed
	Describe the factors involved
	Tail rotor

AUM/Altitude
Position of C of G

- b) Airflow reversal
 - Describe the cause
 - Show the speed variations along the span
 - Show the resultant thrust and where it acts
 - c) Retreating blade stall (RBS)
 - Describe retreating blade flapping
 - Show the relative angle of attack
 - Explain where and why the stall will start
 - List the factors leading to Retreating Blade Stall
 - List the symptoms of RBS
 - State the recovery actions
 - d) Compressibility
 - Explain the effects of high speed affecting the advancing blade
 - Show the rotor profile drag increase
 - e) Flow separation
 - Show how flow separation occurs at varying angles of attack with variation of speed using a blade motion graph
 - Explain the effects of increased AUM
 - Explain the effects of increased altitude
 - f) Shock stall
 - Discuss the effect shock stall has on the co-efficient of lift
 - g) 'G' stall
 - Discuss excessive disc loading
- 082 02 11 06 Inflow roll
Define inflow roll
Describe the distribution of the inflow velocities **across the disc**
State the resultant effect
State the corrective action

082 02 12 00

Factors affecting cyclic stick limits
Discuss the effects of:

082 02 12 01

Mass

082 02 12 02

Density Altitude

082 02 12 03

Position of the C of G.

082 02 13 00

The Flare – powered flight

Define a flare

082 02 13 01

Thrust Reversal

Show the effect of disc tilt to achieve thrust reversal

082 02 13 02

Effect on aircraft attitude

Show the effect of pendulosity

082 02 13 03

Increase in rotor thrust

Show how the variation in induced flow increases the rotor thrust

082 02 13 04

Decrease in rotor drag

- 082 02 13 05 Show how the rotor drag decreases as the total reaction moves
Increase in rotor RPM
Describe the increase in rotor RPM due to:
Reduction in rotor drag
Coriolis effect
- 082 02 13 06 Effect of deceleration
Show the combined effect on deceleration and the recovery from the flare
Discuss the recovery from the flare
- 082 02 14 00 Vortex Ring (settling with power)
State the conditions for the formation of vortex ring
State the situations likely to lead to vortex ring
- 082 02 14 01 Tip Vortices
Discuss the generation of tip vortices and the effect on the induced flow
- 082 02 14 02 Show the effect of rate of descent flow compared with free air flow
- 082 02 14 03 Development of vortex ring
Show the incipient stages
- 082 02 14 04 Show the change in relative airflow between the tip and root
Show how the root stalls and the tip loses thrust
Show the effect of raising the lever
Discuss the effect on the controls
State the need for early recognition and initiation of recovery
State the recovery actions
- 082 02 15 00 Blade sailing
Define blade sailing and state the causes
- 082 02 15 01 Rotor RPM and blade rigidity
Discuss the correlation
- 082 02 15 02 Effect of adverse wind
- 082 02 15 03 Minimising the dangers
Demonstrate the use of a demonstrated wind envelope for engaging/disengaging rotors
- 082 02 16 00 Autorotation – Vertical
Describe autorotation and the entry
- 082 02 16 01 Inflow during the descent flight
Show the flow through the disc
- 082 02 16 02 Describe the effective inflow
Show how the effective inflow varies
- 082 02 16 03 Relative Airflow
Show how the relative airflow varies from power flight
- 082 02 16 04 Inflow and inflow angle
Show how the effective inflow forms the inflow angle
Show how the inflow angle varies from root to tip

	<p>Show how the angle of attack varies with the inflow angle from root to tip</p> <p>Describe how the aerodynamic force (or total reaction) will move depending on the lift/drag ratio of the blade</p>
082 02 16 05	<p>Autorotative force</p> <p>Show how the autorotative force is derived from the total reaction</p> <p>Show that it an accelerative or driving force</p> <p>Show the location of the autorotative section and how it varies along the span of the blade</p>
082 02 16 06	<p>Rotor drag</p> <p>Describe where rotor drag acts along the span of the blade</p> <p>Describe the balance between the autorotative force and rotor drag and the effect on rotor RPM</p>
082 02 16 07	<p>Effect of Mass and Altitude</p> <p>Demonstrate the movement of the autorotative section with changes in mass and altitude.</p>
082 02 16 07	<p>Show the effect on rotor RPM</p> <p>Control of rotor RPM with lever</p> <p>Discuss the reason for the limits of rotor RPM</p> <p>Show the effect on the autorotative section with use of lever</p> <p>Show the effect on rotor drag</p> <p>Show the effect on rate of descent</p>
082 02 16 08	<p>Rotor RPM stability</p> <p>Discuss RPM stability when RPM are disturbed by outside forces</p> <p>Show how the section moves to stabilise the RPM</p>
082 02 17 00	<p>Autorotation – forward flight</p>
082 02 17 01	<p>Factors affecting the inflow angle</p> <p>Describe the following three factors:</p> <p>From disc tilt to achieve a horizontal thrust</p> <p>From horizontal flow affecting the relative airflow</p> <p>Show the effect throughout the speed range from moving into free air</p>
082 02 17 02	<p>Show the resultant effect on the rotor thrust and Rate of Descent</p> <p>Show with a diagram the combined effects</p> <p>Show how the rotor RPM vary with increase in forward speed</p>
082 02 17 03	<p>Asymmetry of the autorotative disc area in forward flight</p> <p>Describe the movement compared with vertical autorotation</p> <p>Discuss the effect on handling</p>
082 02 17 04	<p>Turning</p> <p>Discuss the effect of turning on Rate of Descent and rotor RPM</p>
082 02 17 05	<p>The Flare</p> <ul style="list-style-type: none"> - rotor RPM increase from movement of the autorotative section - increase in rotor thrust due increase in inflow angle - increase in RPM due coriolis effect - reduction in R of D

082 02 17 06	Range and endurance Use a graph to show how they are determined Show the effect of lever to maximise range
082 02 17 07	Autorotative landing Describe a basic engine-off landing Describe the variations and associated problems
082 02 17 08	Height/Velocity diagram Use the height /velocity graph to show when a safe autorotative landing may not be achieved
082 02 18 00	Stability Define static and dynamic stability
082 02 18 01	Hover stability Show how the hover stability is affected in pitch and roll by gusts Determine the pitch and roll stability in the hover Show how the hover directional stability is affected by gusts Determine the hover directional stability
082 02 18 02	Forward flight Determine the translational flight-stability in the pitching plane Determine the translational flight- stability in the rolling plane Determine the forward translational flight-directional stability
082 02 18 03	Determine the rearward translational flight-directional stability
082 02 18 04	Stability aids Describe the use and effect of fixed stabilisers in: - forward flight / rearward flight / the hover / the climb - the autorotation Show the effect of C of G position on stability Gyro controlled stabiliser system: - describe a simple system and show the operation - show a multi channel system Describe the use of stabilators Stabiliser bars Describe the operation of stabiliser bars -State the advantages Delta hinge effect -Describe the use with main rotors
082 02 18 05	State the effect on stability of lever application on attitude in translational flight -Describe the attitude change following lever application and the cause
082 02 19 00	Control power Describe the amount of control power that is available
082 02 19 01	The teetering rotor Describe how the control force is exercised through the rotor head
082 02 19 02	Fully articulated rotor

	<p>Show how the control force operates through the flapping hinges</p> <p>Describe the resultant rate of response</p>
082 02 19 03	<p>Rigid rotor</p> <p>Show how the control force is operated through flexible element</p> <p>Describe the resultant rate of response</p> <p>Compare response from:</p> <p>Teetering / articulated / hingeless rotors</p>
082 02 19 04	<p>Compare the effect on stability of each type</p>
082 02 19 05	<p>Compare the effect on Static/dynamic rollover of each type</p>
082 02 20 00	<p>Power requirements – Graphs (se 082 02 10 00)</p>
082 02 20 01	<p>Power required /power available graph</p> <p>Use the graph to determine:</p>
082 02 20 02	<p>- Maximum rate of climb</p>
082 02 20 03	<p>Operations with limited power</p> <p>-Use the graph to show the limitations on level flight</p> <p>Discuss power checks</p> <p>Discuss density altitude (see 082 02 12 02)</p> <p>Discuss procedures for landing and take-off</p> <p>Discuss manoeuvres with limited power</p>
082 02 20 04	<p>Best angle of climb speed</p> <p>Show how it is derived</p> <p>Discuss the objective</p> <p>Describe the techniques to achieve it</p>
082 02 20 05	<p>Maximum speed</p> <p>Discuss theoretical maximum speed</p> <p>Explain the aerodynamic need for VNE</p> <p>Describe the safety requirement for VNO</p> <p>Show the VNE variation with altitude.</p>
082 02 20 06	<p>Range and Endurance</p> <p>Define endurance speed</p> <p>Show on a graph where it can be found for a piston engine helicopter</p> <p>Show on a fuel flow graph the differences with a turbine engine</p> <p>Define range speed</p> <p>Show on a graph where it can be found for a piston engine helicopter</p> <p>Discuss the efficiency of a turbine engine and specific fuel consumption</p>
082 02 20 07	<p>Overpitching</p> <p>Describe overpitching</p> <p>Show the consequences</p> <p>Discuss the situations likely to lead to overpitching</p>
082 02 20 08	<p>Describe overtorquing</p> <p>Describe the situations likely to lead to overtorquing</p>
082 02 20 09	<p>Turning</p> <p>Show the effects on power required when turning at 30° and 60° of bank</p>

082 02 20 10

Comparison of piston and turbine engine helicopters

Describe and show the basic differences in engine efficiencies

Describe specific fuel consumption

Describe the effects of altitude on the rotor performances

induced power and rotor profile power

Show with the aid of a fuel flow graph: the combined effects of:

- aircraft weight

- density altitude

Discuss with a graph the effects of wind on the range speed