CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

INTRODUCTION

Conventions for questions in subject 081.

1.
The following standard conventions are used for certain mathematical symbols:

*	multiplication.
>=	greater than or equal to.
<=	less than or equal to.
SQRT( )	square root of the function, symbol or number in between brackets.

2.
Normally it should be assumed that the effect of a variable under review is the only variation that needs to be addressed, unless specifically stated otherw

3.
Candidates can expect questions on dedicated topics as described in detail within these Learning Objectives. It should be taken into account that knowledge of different topics within the 081 Learning Objectives can be combined in one question. An example of this can be found on the JAA website www.jaa.nl

4.
Candidates are expected in simple calculations to be able to convert knots into m/s and know the appropriate conversion factors by heart.

5.
For those questions related to propellers (subject 081 07) as a simplification of the physical reality, the inflow speed into the propeller plane is taken as the aeroplane's TAS. In addition, when discussing propeller rotational direction, it will always be specified as seen from behind the propeller plane.

6.
Throughout subject 081 Fly by Wire is not considered.

7.
In the subsonic range as covered under 081 01 compressibility effects normally are not considered, unless specifically mentioned.

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
080 00 00 00	**PRINCIPLES OF FLIGHT**	x	x	x	x	x	
081 00 00 00	**PRINCIPLES OF FLIGHT – AEROPLANE**	x	x				
081 01 00 00	**SUBSONIC AERODYNAMICS**						
081 01 01 00	**Basics, laws and definitions**						
081 01 01 01	Laws and definitions	x	x				

LO	- List the SI-units of measurement for mass, acceleration, weight, velocity, density, temperature, pressure, force, wing loading and power.
	- Define mass, force, acceleration and weight.
	- Describe Newton´s Laws.
	  - Describe Newton´s first law.
	  - Describe Newton’s second law.
	  - Describe Newton’s third law.
	- Explain air density.
	- List the atmospheric properties that effect air density.
	  - Explain how temperature and pressure changes affect density.
	- Define static pressure.
	- Define dynamic pressure.
	  - Define the formula for dynamic pressure.
	    - Apply the formula for a given altitude and speed.
		x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	

	- State Bernoulli´s equation.
	  - Define total pressure.
	  - Apply the equation to a venturi.
	  - Describe how the IAS is acquired from the pitot-static system.
	- Describe the Ideal Gas Law.
	- Describe the Equation of Continuity.
	- Describe viscosity.
	- Define IAS, CAS, EAS, TAS.						

081 01 01 02	Basics about airflow	x	x				
LO	- Describe steady and unsteady airflow. - Explain the concept of a streamline. - Describe and explain airflow through a streamtube. - Explain the difference between two and three-dimensional airflow.	x	x				
081 01 01 03	Aerodynamic forces and moments on aerofoils	x	x				

LO	- Describe the force resulting from the pressure distribution around an aerofoil.
	- Resolve the resultant force into the components 'lift' and ‘drag’.
	- Describe the direction of lift and drag.
	- Define the aerodynamic moment.
	  - List the factors that affect the aerodynamic moment.
	  - Describe the aerodynamic moment for a symmetrical aerofoil.
		x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Describe the aerodynamic moment for a positively cambered aerofoil. - Forces and equilibrium of forces Refer to 081 08 00 00. - Define angle of attack.						
081 01 01 04	Shape of an aerofoil	x	x				
LO	- Describe the following parameters of an aerofoil: - leading edge. - trailing edge. - chord line. - thickness to chord ratio or relative thickness. - location of maximum thickness. - camber line. - camber. - nose radius. - angle of attack. - angle of incidence. (note: in certain textbooks angle of incidence is used as angle of attack, for JAR-FCL purposes this use is discontinued and the angle of incidence is defined as the angle between the aeroplane longitudinal axis and the wing root chord line - Describe a symmetrical and an asymmetrical aerofoil.	x	x				
081 01 01 05	The wing shape	x	x				
LO	- Describe the following parameters of a wing:	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- span. - root chord. - tip chord. - taper ratio. - wing area. - wing planform - mean geometric chord. - mean aerodynamic chord MAC - aspect ratio. - dihedral angle. - sweep angle.						
081 01 02 00	**The two-dimensional airflow about an aerofoil**						
081 01 02 01	Streamline pattern	x	x				
LO	- Describe the streamline pattern over an aerofoil. - Describe converging and diverging streamlines and their effect on static pressure and velocity. - Describe upwash and downwash.	x	x				
081 01 02 02	Stagnation point	x	x				
LO	- Describe the stagnation point. - Explain the effect on the stagnation point of angle of attack changes.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Explain local pressure changes.						
081 01 02 03	Pressure distribution	x	x				
LO	- Describe pressure distribution and local speeds around an aerofoil including effects of camber and angle of attack. - Describe where the minimum local static pressure is typically situated on an aerofoil.	x	x				
081 01 02 04	Centre of pressure and aerodynamic centre	x	x				
LO	- Define the centre of pressure and aerodynamic centre. - Explain stable and unstable centre of pressure movement with angle of attack. (include the effect of camber)	x	x				
081 01 02 05	Lift and downwash	x	x				
LO	- Explain the association between lift and downwash.	x	x				
081 01 02 06	Drag and wake (loss of impulse)	x	x				
LO	- List two physical phenomena that cause drag. - Describe skin friction drag. - Describe pressure (form) drag - Explain why drag and wake cause a loss of energy (momentum).	x	x				
081 01 02 07	Influence of angle of attack	x	x				
LO	- Explain the influence of angle of attack on lift.	x	x				
081 01 02 08	Flow separation at high angles of attack	x	x				
LO	- Refer to 081 01 08 01.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
081 01 02 09	The Lift – α graph	x	x				
LO	- Describe the lift and angle of attack graph. - Explain the significant points on the graph. - Describe lift against α graph for a symmetrical aerofoil.	x	x				
081 01 03 00	**The coefficients**						
LO	- Explain why coefficients are used in general.	x	x				
081 01 03 01	The lift coefficient C_l	x	x				
LO	- Describe the lift formula and perform simple calculations. - Describe the C_l - α graph (symmetrical and positively / negatively cambered aerofoils). - Describe the typical difference in C_l - α graph for fast and slow aerofoil design. - Define the C_{lMAX} and α_{stall} on the graph. - State the approximate stall angle of attack.	x	x				
081 01 03 02	The drag coefficient C_d	x	x				
LO	- Describe the drag formula and perform simple calculations. - Discuss effect of the shape of body on drag coefficient. - Describe the C_l – C_d graph (aerofoil polar). - Indicate minimum drag on the graph. - Explain why the C_l – C_d ratio is important as a measure of performance. - State the normal values of C_l - C_d.	x	x				
081 01 04 00	**The three-dimensional airflow about an aeroplane**						

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
LO	- Define aeroplane angle of attack - Explain the difference between the angle of attack and the attitude of an aeroplane.	x	x				
081 01 04 01	Streamline pattern	x	x				

LO	- Describe the general streamline pattern around the wing, tail section and fuselage.
	- Explain and describe the causes of spanwise flow over top and bottom surfaces.
	- Describe tip vortices and local α.
	  - Explain how tip vortices vary with angle of attack.
	  - Explain upwash and downwash due to tip vortices.
	  - Describe span-wise lift distribution including the effect of wing planform.
	  - Describe the causes, distribution and duration of the wake turbulence behind an aeroplane.
	    - Describe the influence of flap deflection on the tip vortex.
	    - List the parameters that influence the wake turbulence.
		x	x				

081 01 04 02	Induced drag	x	x				
LO	- Explain what causes the induced drag. - Describe the approximate formula for the induced drag coefficient. - State the factors that affect induced drag. - Describe the relationship between induced drag and total drag in the cruise. - Describe the effect of mass on induced drag at a given IAS. - Describe the design means to decrease induced drag:	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- aspect ratio - winglets. - tip tanks. - wing span loading. - influence of wing twist. - influence of camber change. - influence of lift distribution - Describe the influence of tip vortices on the angle of attack. - Explain induced and effective local angle of attack. - Explain the influence of the induced angle of attack on the direction of the lift vector. - Explain the relationship between induced drag and: - speed. - aspect ratio. - wing planform. - bank angle in a horizontal co-ordinated turn - Explain the induced drag coefficient. - Explain the relationship between the induced drag coefficient and the angle of attack or lift coefficient. - Explain the influence of induced drag on: - C_L – angle of attack graph, show effect on graph when comparing high and low aspect ratio wings.						

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- C_L - C_D (aeroplane polar), show effect on graph when comparing high and low aspect ratio wings. - parabolic aeroplane polar in a graph and as a formula. ($C_D = C_{Dp} + kC_L^2$)						
081 01 05 00	**The total drag**						
081 01 05 01	The parasite drag	x	x				
LO	- List the types of drag that are included in the parasite drag. - Describe pressure (form) drag. - Describe interference drag. - Describe friction drag.	x	x				
081 01 05 02	The parasite drag and speed	x	x				
LO	- Describe the relationship between parasite drag and speed.	x	x				
081 01 05 03	The induced drag and speed	x	x				
LO	- Refer to 081 01 04 02.	x	x				
081 01 05 04	Intentionally left blank	x	x				
081 01 05 05	The total drag and speed	x	x				
LO	- Describe total drag – IAS graph and the drag components which contribute to this graph.	x	x				
081 01 05 06	Minimum total drag	x	x				
LO	- Indicate the IAS for the minimum drag from the graph. - Explain under what condition the minimum drag occurs	x	x				
081 01 05 07	The total drag – speed graph	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	

LO	- Describe the effect of aeroplane gross mass on the graph.
	- Describe the effect of pressure altitude on:
	  - drag – IAS graph.
	  - drag – TAS graph.
	- Describe speed stability from the graph.
	  - Describe non-stable, neutral and stable IAS regions.
	  - Explain what happens to the IAS and drag in the non-stable region if speed suddenly decreases.
		x	x				

081 01 06 00	**The ground effect**						
LO	- Explain what happens to the tip vortices, downwash, airflow pattern and lift and drag in ground effect.	x	x				
081 01 06 01	Effect on C_{Di}	x	x				
LO	- Describe the influence of ground effect on C_{Di} and induced angle of attack. - Explain the effects on entering and leaving ground effect.	x	x				
081 01 06 02	Effect on α_{stall}	x	x				
LO	- Describe the influence of ground effect on α_{stall}.	x	x				
081 01 06 03	Effect on C_L	x	x				
LO	- Describe the influence of ground effect on C_L.	x	x				
081 01 06 04	Effect on take-off and landing characteristics of an aeroplane	x	x				
LO	- Describe the influence of ground effect on take-off and landing characteristics and performance of an aeroplane.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Describe the difference between: - high and low wing characteristics. - high and low tail characteristics. - Explain the effects on static pressure measurements at the static ports when entering and leaving ground effect.						
081 01 07 00	**The relation between the lift coefficient and the speed for constant lift**						
LO	- Describe the relationship between lift coefficient and speed for constant lift as a formula.	x	x				
081 01 07 01	As a formula	x	x				
LO	- Explain the effect on C_L during speed increase/decrease in level flight and perform						
081 01 07 02	In a graph	x	x				
LO	- Explain using a graph, the effect on speed at various angles of attack and C_L, at a given weight. - Calculate the change of C_L as a function of IAS.						
081 01 08 00	**The Stall**						
081 01 08 01	Flow separation at increasing angles of attack	x	x				
LO	- Define the boundary layer. - Describe the thickness of a typical boundary layer. - List the factors that effect the thickness. - Describe the laminar layer. - Describe the turbulent layer.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Define the transition point. - List the differences between laminar and turbulent boundary layers. - Explain why the laminar boundary layer separates easier than the turbulent one. - List the factors that slow down the airflow over the aft part of an aerofoil, as angle of attack is increased. - Define the separation point and describe its location as a function of angle of attack. - Define the critical or stall angle of attack. - Describe the influence of increasing the angle of attack on: - the forward stagnation point. - the pressure distribution. - location of the centre of pressure (straight and swept back wing). - C_L and L. - C_D and D. - the pitching moment (straight and swept back wing). - the downwash at the horizontal stabiliser. - Explain what causes the possible natural buffet on the controls in a pre-stall condition. - Describe the effectiveness of the flight controls in a pre-stall condition. - Describe and explain the normal post-stall behaviour of a wing / aeroplane. - Describe the dangers of using the controls close to the stall.						
081 01 08 02	The stall speed	x	x				

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	

LO	- Solve the 1g stall speed from the lift formula.
	- Define the FAA stall speed.
	- Describe and explain the Influence of the following parameters on the stall speed:
	  - centre of gravity.
	  - power setting, thrust component and slipstream effect.
	  - wing loading (W/S) or gross weight
	  - wing contamination.
	  - angle of sweep.
	  - altitude (for compressibility effects see 081 02 04 01).
	- Define the load factor n.
	  - Describe the general idea why the load factor increases in turns.
	  - Explain why the load factor increases in a pull-up and decreases in a push-over manoeuvre.
	  - Describe and explain the Influence of the load factor (n) on the stall speed.
	  - Explain the expression: accelerated stall.
	
	Note: sometimes accelerated stall is also erroneously referred to as high speed stall. High speed stall and high speed buffet will be used exclusively for high speed characteristics, which are more fully treated in subchapter 2, since in this case compressibility effects are included.
	  - Calculate the change of stall speed as a function of the load factor.
	  - Calculate the increase of stall speed in a horizontal co-ordinated turn as a function of
		x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	bank angle. - Calculate the change of stall speed as a function of the gross mass.						
081 01 08 03	The initial stall in span-wise direction	x	x				
LO	- Explain the initial stall sequence on the following planforms: - elliptical. - rectangular. - moderate and high taper. - sweepback or delta. - Explain the influence of aerodynamic twist (wash out) and geometric twist. - Explain the influence of deflected ailerons. - Explain the influence of fences, vortilons, saw teeth, vortex generators.	x	x				
081 01 08 04	Stall warning	x	x				
LO	- Explain why stall warning is necessary. - Explain when aerodynamic and artificial stall warnings are used. - Explain why JAR/CS 23/25 and FAR require a margin to stall speed. - Describe: - buffet. - stall strip. - flapper switch (leading edge stall warning vane). - angle of attack vane. - angle of attack probe.	x	x				

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- stick shaker. - Describe the recovery after: - stall warning. - stall. - stick pusher actuation.						
081 01 08 05	Special phenomena of stall	x	x				
LO	- Describe the basic stall requirements for JAR / CS / FAR transport category aeroplanes. - Explain the difference between the power-off and power-on stalls and recovery. - Describe the stall and recovery in a climbing and descending turn. - Describe the effect on stall and recovery characteristics of: - wing sweep (consider both forward and backward sweep). - T-tailed aeroplane. - canards. - Describe super- or deep-stall. - Describe the philosophy behind the stick pusher system. - Explain the effect of ice, frost or snow on the stagnation point. - Explain the absence of stall warning. - Explain the abnormal behaviour of the stall. - Describe and explain cause and effects of the stabiliser stall (negative tail stall). - Describe when to expect in-flight icing.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Explain how the effect is changed when retracting/extending lift augmentation devices. - Describe how to recover from a stall after a configuration change caused by in-flight icing. - Explain the effect of a contaminated wing. - Explain what "on-ground" icing is. - Describe the aerodynamic effects of de/anti-ice fluid after the holdover time has been reached. - Describe the aerodynamic effects of heavy tropical rain on stall speed and drag. - Explain how to avoid spins. - List the factors that cause a spin to develop. - Describe spin development, recognition and recovery. - Describe the differences in recovery techniques for aeroplanes that have different mass distributions between the wing and the fuselage.						
081 01 09 00	**C_{Lmax} augmentation**						
081 01 09 01	Trailing edge flaps and the reasons for use in take-off and landing	x	x				
LO	- Describe trailing edge flaps and the reasons for their use during take-off and landing. - Identify the differing types of trailing edge flaps given a relevant diagram. - Split flaps. - Plain flaps. - Slotted flaps.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Fowler flaps. - Describe their effect on wing geometry. - Describe how the wing's effective camber increases. - Describe how the effective chord line differs from the normal chord line. - Describe their effect on location of centre of pressure. - Describe their effect on the stall speed. - Describe their effect on aeroplane pitching moments. - Compare their influence on the C_L - α graph. - Indicate the variation in C_L at any given angle of attack. - Indicate the variation in C_D at any given angle of attack. - Indicate their effect on C_{LMAX}. - Indicate their effect on the stall or critical angle of attack. - Indicate their effect on angle of attack at a given C_L. - Compare their influence on the C_L - C_D graph. - Indicate how the $(C_L/C_D)_{MAX}$ differs from that of a clean wing. - Explain the influence of trailing edge flap deflection on glide angle. - Describe flap asymmetry. - Explain the effect on aeroplane controllability. - Describe trailing edge flap effect on take-off and landing. - Explain the advantages of lower nose attitudes.						

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Explain why take-off and landing speeds/distances are reduced.						
081 01 09 02	Leading edge devices and the reasons for use in take-off and landing	x	x				

LO	- Describe leading edge high lift devices.
	- Identify the differing types of leading edge high lift devices given a relevant diagram:
	  - Krueger flaps.
	  - variable camber flaps.
	  - slats.
	- State their effect on wing geometry.
	- Describe the function of the slot.
	  - Describe how the wing's effective camber increases.
	  - Describe how the effective chord line differs from the normal chord line.
	- State their effect on the stall speed, also in comparison with trailing edge flaps.
	- Compare their influence on the C_L - α graph, compared with trailing edge flaps and a clean wing.
	  - Indicate the effect of leading edge devices on C_{LMAX}.
	  - Explain how the C_L curve differs from that of a clean wing.
	  - Indicate the effect of leading edge devices on the stall or critical angle of attack.
	- Compare their influence on the C_L - C_D graph.
	- Describe slat asymmetry.
	  - Describe the effect on aeroplane controllability.
		x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	

	- deleted transferred to subject 021
	- Explain the reasons for using leading edge high lift devices on take-off and landing.
	  - Explain the disadvantage of increased nose up attitudes.
	  - Explain why take-off and landing speeds/distances are reduced.						

081 01 09 03	Vortex generators	x	x				
LO	- Explain the purpose of vortex generators. - Describe their basic operating principle. - State their advantages and disadvantages.	x	x				
081 01 10 00	**Means to decrease the C_L – C_D ratio, increasing drag**						
081 01 10 01	Spoilers and the reasons for use in the different phases of flight	x	x				
LO	- Describe spoilers their aerodynamic functioning and the reasons for use in the different phases of flight. - Roll spoilers. - Flight spoilers (speed brakes). - Ground spoilers (lift dumpers). - Describe the operation of ground spoilers (lift dumpers). - Describe the purpose of a spoiler-mixer unit. - Describe the effect of spoilers on the C_L - α graph and stall speed - Describe the influence of spoilers on the C_L – C_D graph and lift/drag ratio.	x	x				
081 01 10 02	Speed brakes as a means of increasing drag and the reasons for use in the different phases of flight	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	

LO	- Describe speed brakes and the reasons for use in the different phases of flight.
	- State their influence on the C_L - C_D graph and lift/drag ratio.
	  - Explain how speed brakes increase parasite drag.
	  - Describe how speed brakes affect the minimum drag speed.
	  - Describe their effect on rate and angle of descent.
		x	x				

081 01 11 00	**The boundary layer**						
081 01 11 01	Different types	x	x				
LO	- Refer to 081 01 08 01.	x	x				
081 01 11 02	Their advantages and disadvantages on pressure drag and friction drag	x	x				
081 01 12 00	**Special circumstances**						
081 01 12 01	Ice and other contamination	x	x				

LO	- Explain the effect of ice, and other contamination and very heavy rain on aeroplane performance.
	- Describe the effects of ice accumulations at the stagnation point and discuss other locations in relation to magnitude of ice build up.
	- Describe the effects of ice, frost, snow on the surface condition.
	  - Describe how it affects the boundary layer.
	- Describe how rain and other liquids affect the surface condition.
	  - Describe its effect on aeroplane mass.
	  - Explain its effect on lift and drag.
	- Describe the effect of contamination of the leading edge.
		x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Explain the effect on aeroplane controllability. - List the causes of leading edge contamination. - Describe the effects of contamination on the stall. - Describe the effect on the boundary layer condition. - Describe the effect on the stall angle of attack. - Describe the effect on the stall speed. - Describe how contamination leads to loss of controllability. - State the effect of tail icing. - Explain the adverse effects of icing on the various phases during take-off. - Describe the effects on control surface moment (stick forces). - Describe the influence of contamination on high lift devices during take-off, landing and low speeds. - Explain why contamination degrades high lift devices' efficiency. - Explain why contamination increases the take-off and landing distances/speeds. - Describe how contamination reduces the coefficient of lift. - Explain the effect of contamination on the lift/drag ratio.						
081 01 12 02	Deformation and modification of airframe, ageing aeroplanes	x	x				
LO	- Describe the effect of airframe deformation and modification of an ageing aeroplane on aeroplane performance. - Explain the effect on boundary layer condition of an ageing aeroplane.	x	x				
081 02 00 00	**HIGH SPEED AERODYNAMICS**						

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
081 02 01 00	**Speeds**						
081 02 01 01	Speed of sound	x					
LO	- Define speed of sound - Explain the variation of the speed of sound with altitude - Describe the influence of temperature on the speed of sound	x					
081 02 01 02	Mach number	x					
LO	- Define Mach number as a function of TAS and speed of sound.	x					
081 02 01 03	Influence of temperature and altitude on Mach number	x					
LO	- Explain the absence of change of Mach number with varying temperature at constant flight level and Calibrated Airspeed. - Explain the change of TAS as a function of altitude at a given Mach number. - Explain the change of Mach number at varying altitude in the standard atmosphere (troposphere and stratosphere) with constant Calibrated Airspeed and with constant True Airspeed. - Referring to 081 06 01 04 and 081 06 01 05 explain that V_{MO} can be exceeded during a descent at constant Mach number and that M_{MO} can be exceeded during a climb at constant IAS	x					
081 02 01 04	Compressibility	x					
LO	- State that compressibility means that density can change along a streamline. - Describe how the streamline pattern changes due to compressibility. - State that Mach number is a measure of compressibility.	x					
081 02 01 05	Subdivision of aerodynamic flow	x					

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
LO	- List the subdivision of aerodynamic flow: - subsonic flow. - transonic flow. - supersonic flow. - Describe the characteristics of the flow regimes listed above. - State the approximate Mach numbers for the different flow regimes	x					
081 02 02 00	**Shock waves**						
LO	- Define a shock wave - Explain loss of total pressure in a shock wave	x					
081 02 02 01	Normal shock waves	x					
LO	- Describe a normal shock wave with respect to: - static temperature, static and total pressure, velocity, local speed of sound, Mach number and density changes. - orientation relative to the wing surface. - Explain the influence of increasing Mach number on a normal shock wave, at positive lift, with respect to: - strength. - length. - position relative to the wing. - second shock wave at the lower surface.	x					

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Explain the effect of angle of attack influence on shock wave intensity at constant Mach number - Discuss the bow wave						
081 02 02 02	Oblique shock waves	x					
LO	- Describe a oblique shock wave with respect to: - static temperature, static and total pressure, velocity, local speed of sound, Mach number and density changes. - Compare characteristics of normal and oblique shock waves.	x					
081 02 02 03	Mach cone	x					
LO	- Define Mach angle μ. with a formula and perform simple calculations. delete, covered under new 081 02 02 01 - Identify the Mach cone zone of influence of a pressure disturbance due to the presence of the aeroplane. - Explain “sonic boom”	x					
081 02 03 00	**Expansion waves**						
LO	- Describe expansion waves with respect to the streamline pattern and variation of static and total pressure, static temperature, density, local speed of sound, Mach number and velocity along a streamline.	x					
081 02 04 00	**Effects of exceeding M_{crit}**						
LO	note: The original heading of this topic was “Effects of compressibility”. It is under consideration to simplify the aerodynamic reality into a model, where effects of compressibility first occur as M_{crit} is exceeded.	x					

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
081 02 04 01	Effect on lift	x					

LO	- Explain shock induced separation, shock stall and describe its relationship with Mach buffet.
	- Describe the consequences of exceeding M_{crit} with respect to:
	  - gradient of the CL-α graph.
	  - C_{LMAX} (stall speed).
	- Explain the change in stall speed (IAS) with altitude.
	- Discuss effect of compressibility on critical or stalling angle of attack
		x					

081 02 04 02	Effect on drag	x					
LO	- Describe wave drag - Explain the behavior of C_D versus M at constant angle of attack. - Explain effect of Mach number on the C_L-C_D graph. - Explain drag divergence Mach number	x					
081 02 04 03	Effect on pitching moment	x					
LO	- Discuss effect of Mach number on the location of centre of pressure and aerodynamic centre - Explain “tuck” effect - List the aerodynamic and mechanical counter measures for the Mach tuck-under effect. - Discuss aerodynamic functioning of the Mach trim system	x					
081 02 04 04	Effect on control effectiveness	x					
LO	- Discuss compressibility effects on the functioning of control surfaces	x					

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
081 02 04 05	Aerodynamic heating	x					
LO	- State that aerodynamic heating is caused by compression and friction.	x					
081 02 04 06	M_{crit}	x					
LO	- Define M_{crit}. - Explain how a change in angle of attack influences M_{crit}. - Discuss effect of control surface deflection on M_{crit} and location of the shock wave.	x					
081 02 05 00	**Buffet onset boundary.**						
081 02 05 01	Manoeuvre capability chart	x					

LO	- Explain the buffet onset boundary (Manoeuvre capability) chart.
	- Explain the concept of buffet margin and describe the influence of the followinng parameters:
	  - angle of attack
	  - Mach number
	  - pressure altitude
	  - mass
	  - load factor
	  - angle of bank
	  - CG location
	- Explain the purpose of the “1.3g” altitude.
	- Describe what can be obtained from the buffet boundary chart.
		x					

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Find (using an example graph): - buffet restricted speed limits at a given pressure altitude. - aerodynamic ceiling at a given mass. - load factor and bank angle at which buffet occurs at a given mass, Mach number and pressure altitude. - buffet free range. - Illustrate the behaviour of the buffet margin when an aeroplane is descending or ascending at a given indicated airspeed, or Mach number. - Describe the effect of exceeding the speed for buffet onset. - Explain the expression “coffin corner”.						
081 02 06 00	**Means to influence M_{crit}**						
081 02 06 01	Wing sweep	x					
LO	- Explain the influence of the angle of sweep with respect to: - the increase of M_{crit}. - effective thickness/chord change or velocity component perpendicular to the quarter chord line. - Describe the influence of the angle of sweep at subsonic speed with respect to - C_{LMAX}. - efficiency of high lift devices. - pitch-up stall behaviour. - Discuss effect of wing sweep on drag	x					

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
081 02 06 02	Aerofoil shape	x					

LO	- Explain use of thin aerofoils with little camber.
	- Explain the main purpose of supercritical aerofoils.
	- Identify the shape characteristics of a supercritical aerofoil shape:
	- Explain with respect to a supercritical aerofoil:
	  - the increased number of smaller and weakened shock waves compared those of a classic profile.
	  - the absence of a strong influence on M_{crit}.
	  - aft loading.
	  - how the beneficial effects of supercritical aerofoils are achieved.
	- Explain the advantages and disadvantages of a supercritical aerofoils for wing design:
		x					

081 02 06 03	Vortex generators	x					
LO	- Explain the use of vortex generators as a means to avoid or restrict flow separation.	x					
081 02 06 04	Area ruling	x					
LO	- Explain area ruling in aeroplane design.	x					
081 03 00 00	**Intentionally left blank**						
081 04 00 00	**STABILITY**						
081 04 01 00	**Condition of equilibrium in steady wings level flight**						
081 04 01 01	Precondition for static stability	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	

LO	- Explain an equilibrium of forces and moments as the condition for the concept of static stability.
	- Identify:
	  - static longitudinal stability.
	  - static directional stability.
	  - static lateral stability.
		x	x				

081 04 01 02	Sum of moments	x	x				
LO	- Identify the moments considered in the equilibrium of moments: moments about all three axes. - discuss effect of sum of moments not being zero	x	x				
081 04 01 03	Sum of forces	x	x				
LO	- Identify the forces considered in the equilibrium of forces.	x	x				
081 04 02 00	**Methods of achieving balance**						
081 04 02 01	Wing and empennage (tail and canard)	x	x				
LO	- Explain the stabiliser and the canard as the means to satisfy the condition of nullifying the total sum of the moments about the lateral axis. - Explain the influence of the location of the wing centre of pressure relative to the centre of gravity on the magnitude and direction of the balancing force on stabiliser and canard. - Explain the influence of the indicated airspeed on the magnitude and direction of the balancing force on stabiliser and canard. - Explain the influence of the balancing force on the magnitude of the wing/fuselage lift.	x	x				
081 04 02 02	Control surfaces	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
LO	- Explain the use of the elevator deflection or stabiliser angle for the generation of the balancing force. - Explain the elevator deflection required to balance thrust changes.	x	x				
081 04 02 03	Ballast or weight trim	x	x				
LO	- Explain the most advantageous location of the centre of gravity. - Explain the control of the location of the centre of gravity by means of fuel distribution and loading.	x	x				
081 04 03 00	**Static and dynamic longitudinal stability**						
081 04 03 01	Basics and definitions	x	x				

LO	- Define static stability.
	- Identify a statically stable, neutral and unstable equilibrium.
	- Define dynamic stability.
	  - Identify a dynamically stable, neutral and unstable motion.
	  - Identify periodic and aperiodic motion
	  - Explain what combinations of static and dynamic stability will return an aeroplane to the equilibrium state after a disturbance.
	- Describe the phugoid and short period motion in terms of period, damping, variations (if applicable) in speed, altitude and angle of attack.
	- Explain why short period motion is more important for flying qualities than the phugoid.
	- Define and describe pilot induced oscillations.
	- Explain the effect of high altitude on dynamic stability.
		x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
081 04 03 02	Static stability	x	x				
LO	- Explain static stability. - Explain manoeuvrability - Discuss effect of cg location on manoeuvrability. - Explain the changes in aerodynamic forces when varying angle of attack for a static longitudinally stable aeroplane.	x	x				
081 04 03 03	Neutral point/location of neutral point	x	x				
LO	- - Define neutral point and describe acceptable locations. - Explain why the location of the neutral point is only dependent on the aerodynamic design of the aeroplane.	x	x				
081 04 03 04	Factors affecting neutral point:	x	x				
LO	- Indicate the location of the neutral point relative to the locations of the aerodynamic centre of the wing and tail/canard. - Explain the influence of the downwash variations with angle of attack variation on the location of the neutral point. - Explain the contribution of engine nacelles.	x	x				
081 04 03 05	Location of centre of gravity	x	x				
LO	- Explain the influence of the location of the centre of gravity on static and dynamic longitudinal stability of the aeroplane. - Explain the approved forward and aft limits of the centre of gravity with respect to the	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	criteria of longitudinal control forces, elevator effectiveness and stability. - Define the minimum stability margin.						
081 04 03 06	The $C_m – \alpha$ graph	x	x				
LO	- Define the aerodynamic pitching moment coefficient (C_m). - Describe the C_m-α graph with respect to: - positive and negative sign. - linear relationship. - angle of attack for equilibrium state. - relationship of slope and static stability.	x	x				
081 04 03 07	Factors affecting the $C_m – \alpha$ graph:	x	x				
LO	- Explain: - the effect on the C_m-α graph with a shift of CG in the forward and aft direction. - the effect on the C_m-α graph when the elevator is moved up or down. - the effect on the C_m-α graph when the trim is moved. - the wing contribution and the effect of the location of the CG with respect to the aerodynamic centre on the wing contribution - the contribution of the fuselage and the effect of the location of the centre of gravity on the fuselage contribution. - the contribution of the tail. - the contribution of the configuration (gear and flaps). - the contribution of aerofoil camber.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
081 04 03 08	The elevator position – speed graph (IAS)	x	x				

LO	- Describe the elevator position speed graph.
	- Explain:
	  - the gradient of the elevator position speed graph.
	  - the influence of the airspeed on the stick position stability.
		x	x				

081 04 03 09	Factors affecting the elevator position – speed graph:	x	x				

LO	- Explain the contribution on the elevator position - speed graph of:
	  - location of centre of gravity.
	  - trim (trim tab and stabiliser trim).
	  - high lift devices.
		x	x				

081 04 03 10	The stick force versus speed graph (IAS)	x	x				

LO	- Define the stick force speed graph.
	- Describe the minimum gradient for stick force versus speed that is required for certification according JAR / CS 23 and JAR / CS 25.
	- Explain the importance of the stick force gradient for good flying qualities of an aeroplane.
	  - Identify the trim speed in the stick force speed graph.
	  - Explain how a pilot perceives stable static longitudinal stick force stability.
		x	x				

081 04 03 11	Factors affecting the stick force versus speed graph:	x	x				
LO	- Explain the contribution of: - location of the centre of gravity.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- trim (trim tab and stabiliser trim). - downspring. - bob weight. - friction.						
LO	- Explain the contribution of: - Mach number and the effect of Mach tuck-under and the Mach trim system. - State that: - in transonic flow due to the Mach tuck under effect the stick force gradient may be too small or unstable. - the Mach trim system restores stick force gradient - Explain corrective measures when the Mach trim fails.	x					
081 04 03 12	The manoeuvring stability/stick force per g	x	x				
LO	- Define the stick force per g. - Explain why: - the stick force per g has a prescribed minimum and maximum value. - the stick force per g decreases with pressure altitude at the same indicated airspeeds.	x	x				
081 04 03 13	Intentionally left blank						
081 04 03 14	Factors affecting the manoeuvring stability/stick force per g:	x	x				
LO	- Explain that the stick force per g is: - dependent on location of centre of gravity and describe how it changes.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- independent of the trim setting. - independent of a down spring in the control system. - greater with the application of a bob weight in the control system.						
081 04 03 15	Stick force per g and the limit load factor	x	x				
LO	- Explain why the prescribed minimum and maximum values of the stick force per g are dependent on the limit load factor. - Calculate the stick force to achieve a certain load factor at a given manoeuvre stability.	x	x				
081 04 03 16	Refer to 081 01 08 05 and 081 05 02 03	x	x				
081 04 04 00	**Static directional stability**						
LO	- Define static directional stability. - Explain the effects of static directional stability being too small or too large	x	x				
081 04 04 01	Sideslip angle ß	x	x				
LO	- Define sideslip angle. - Identify β as the symbol used for the sideslip angle.	x	x				
081 04 04 02	Yaw moment coefficient C_n	x	x				
LO	- Define the yawing moment coefficient C_n. - Define the relationship between Cn and β for an aeroplane with static directional stability.	x	x				
081 04 04 03	C_n – ß graph	x	x				
LO	- Explain why: - C_n depends on the angle of sideslip.	x	x				

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- C_n equals zero for that angle of sideslip that provides static equilibrium about the aeroplane's normal axis. - if no asymmetric engine thrust, flight control or loading condition prevails, the equilibrium angle of sideslip equals zero. - Identify how the slope of the Cn - β graph is a measure for static directional stability.						
081 04 04 04	Factors affecting static directional stability:	x	x				
LO	- Describe how the following aeroplane components contribute to static directional stability: - wing. - fin. - dorsal fin. - ventral fin. - angle of sweep of the wing. - angle of sweep of the fin. - fuselage at high angles of attack. - strakes. - Mach number - Explain why both the fuselage and the fin contribution reduce static directional stability after an aft shift of the centre of gravity.	x	x				
081 04 05 00	**Static lateral stability**						
LO	- Define static lateral stability. - Explain the effects of static lateral stability being too small or too large.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
081 04 05 01	Bank angle ø	x	x				
LO	- Define bank angle Ø	x	x				
081 04 05 02	The roll moment coefficient C_l	x	x				
LO	- Define the roll moment coefficient C_l.	x	x				
081 04 05 03	Contribution of sideslip angle ß	x	x				
LO	- Explain how without co-ordination, the bank angle creates sideslip angle.	x	x				
081 04 05 04	The C_l – ß graph	x	x				
LO	- Describe C_l - β graph. - Identify the slope of the C_l - β graph as a measure for static lateral stability.	x	x				
081 04 05 05	Factors affecting static lateral stability:	x	x				

LO	- Explain the contribution to the static lateral stability of:
	  - dihedral, anhedral.
	  - high wing, low wing.
	  - sweep angle of the wing.
	  - ventral fin.
	  - vertical tail.
	  - Mach number.
	  - altitude.
	- Define dihedral effect
		x	x				

081 04 05 06	Effective lateral stability	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	

LO	- Define effective dihedral.
	- Explain the negative effects of high static lateral stability in:
	  - strong crosswind landings.
	  - asymmetric thrust situations at high power setting and low speed (go-around, take off).
		x	x				

081 04 06 00	**Dynamic lateral/directional stability**						
081 04 06 01	Effects of asymmetric propeller slipstream	x	x				
081 04 06 02	Tendency to spiral dive	x	x				
LO	- Explain how lateral and directional stability are coupled. - Explain how high static stability and a low static lateral stability may cause spiral divergence (unstable spiral dive) and under which conditions the spiral dive mode is neutral or stable. - Describe an unstable spiral dive mode with respect to deviations in speed, roll attitude, nose low pitch attitude and decreasing altitude.	x	x				
081 04 06 03	Dutch roll	x	x				

LO	- Describe Dutch roll.
	- Explain:
	  - why Dutch roll occurs when the static lateral stability is large compared to static directional stability.
	  - the condition for a stable Dutch roll motion and those for marginally stable, neutral or unstable Dutch roll motion.
	  - the function of the yaw damper.
		x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- actions to be taken in case of non-availability of the yaw damper.						
081 04 06 04	Effects of altitude on dynamic stability	x	x				
LO	- Explain that increased pressure altitude reduces dynamic lateral/directional stability, include effect of Mach number.	x					
081 05 00 00	**CONTROL**						
081 05 01 00	**General**						
081 05 01 01	Basics, the Three Planes and Three Axis	x	x				
LO	- Define: - lateral axis. - longitudinal axis. - normal axis. - Define: - pitch angle. - roll angle. - yaw angle. - Describe the motion about the three axes. - Name and describe the devices that control these motions.	x	x				
081 05 01 02	Camber change	x	x				
LO	- Explain how camber is changed by movement of a control surface.	x	x				
081 05 01 03	Angle of attach change	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
LO	- Explain the influence of local angle of attack change by movement of a control surface.	x	x				
081 05 02 00	**Pitch control**						
081 05 02 01	Elevator/all flying tails	x	x				
LO	- Explain the working principle of the horizontal tailplane (stabiliser) - Discuss advantages and disadvantages of T-tails. - Explain the working principle of the elevator and describe its function. - State graphically the effect of elevator deflection on the moment curve. - Explain why the moment curve is independent of angle of attack. - Describe the loads on the tailplane in normal flight, lower than normal flight speeds, and higher than normal speed.	x	x				
081 05 02 02	Downwash effects	x	x				
LO	- Explain the effect of downwash on the tailplane angle of attack. - Explain in this context the use of a T-tail or stabiliser trim.	x	x				
081 05 02 03	Ice on tail	x	x				
LO	- Explain how ice can change the aerodynamic characteristics of the tailplane. - Explain how this can affect the tail's proper function.	x	x				
081 05 02 04	Location of centre of gravity	x	x				

LO	- Explain the relationship between pitching moment coefficient and lift coefficient.
	  - Explain the relationship between elevator deflection and location of cg in straight flight, and in a manoeuvre with a load factor higher or lower than 1
	  - Explain effect of forward cg limit on pitch control.
		x	x				

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
081 05 03 00	**Yaw control**						
LO	- Explain the working principle of the rudder and describe its function. - State the relationship between rudder deflection and the moment about the normal axis. - Describe the effect of sideslip on the moment about the normal axis.	x	x				
081 05 03 01	Pedal/Rudder ratio changer	x	x				
LO	- Describe the purpose of the rudder ratio changer.	x	x				
081 05 03 02	Moments due to engine thrust	x	x				
LO	- Describe the effect of engine thrust on pitching moments - Explain fin stall due to rudder displacement.	x	x				
081 05 03 03	Engine failure (n – 1)	x	x				
LO	- Refer to 081 08 02 00.	x	x				
081 05 04 00	**Roll control**						
081 05 04 01	Ailerons	x	x				
LO	- Explain the functioning of ailerons. - Describe the adverse effects of ailerons. refer to 081 05 04 04 and 081 06 01 02 - Explain in this context the use of inboard and outboard ailerons. - Explain outboard aileron lockout and conditions under which this feature is used. - Describe the use of aileron deflection in normal flight, flight with sideslip, cross wind landings, horizontal turns, flight with one engine out.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Define roll rate. - List the factors that effect roll rate. - Flaperons, aileron droop.						
081 05 04 02	Intentionally left blank						
081 05 04 03	Spoilers	x	x				
LO	- refer to 081 01 10 00 - Explain how spoilers can be used to control the rolling movement in combination with or instead of the ailerons.	x	x				
081 05 04 04	Adverse yaw	x	x				
LO	- Explain how the use of ailerons induces adverse yaw.	x	x				
081 05 04 05	Means to avoid adverse yaw	x	x				

LO	- Explain how the following reduce adverse yaw:
	  - frise ailerons.
	  - differential ailerons deflection.
	  - coupling aileron deflection.
	  - roll spoilers.
	  - effects of asymmetric propeller slipstream.
		x	x				

081 05 05 00	**Interaction in different planes (yaw/roll)**						
LO	- Describe the coupling effect of roll and yaw. - Explain the secondary effect of ailerons.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Explain the secondary effect of rudder.						
081 05 05 01	Limitations of asymmetric power	x	x				
LO	- Refer to 081 08 02 06.	x	x				
081 05 06 00	**Means to reduce control forces**						
081 05 06 01	Aerodynamic balance	x	x				

LO	- Describe the working principle of the nose and horn balancing (positioning of the hinge line in elevator, aileron and rudder).
	- Describe the working principle of internal balance.
	- Describe the working principle of:
	  - balance tab.
	  - anti-balance tab.
	  - spring tab.
	  - servo tab.
	- Mention where, when and why these devices are applied
		x	x				

081 05 06 02	Artificial	x	x				

LO	- List examples of artificial means of to reduce/increase aerodynamic force.
	  - Describe fully powered controls.
	  - Describe power assisted controls.
	- Explain why artificial feel is required.
	  - Explain how artificial feel is produced (inputs).
		x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Dynamic pressure. - Stabiliser setting. - Elevator deflection						
081 05 07 00	**Mass balance**						
LO	- Refer to 081 06 01 00 for mass balance. - Refer to 081 04 03 11 and 081 04 03 14 for bob weight.	x	x				
081 05 07 01	Reasons to balance	x	x				
LO	- Reasons to use mass balance.	x	x				
081 05 08 00	**Trimming**						
081 05 08 01	Reasons to trim	x	x				
LO	- State the reasons for trimming devices. - Explain the difference between a trim tab and the various balance tabs.	x	x				
081 05 08 02	Trim tabs	x	x				
LO	- Describe the working principle of a trim tab including cockpit indications.	x	x				
081 05 08 03	Stabiliser trim/Trim rate versus IAS	x	x				
LO	- Describe stabiliser trim/trim rate versus IAS. - Explain the advantages and disadvantages of a stabiliser trim compared with a trim tab. - Discuss the effects of jammed and runaway stabiliser.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Explain elevator deflection when aeroplane is trimmed for fully powered and power assisted pitch controls. - Explain the factors influencing stabiliser setting: - in-flight. - before take-off. - Explain the influence of take-off stabiliser trim setting on stick force during rotation at varying cg positions within the allowable cg range. - Explain the landing technique with a jammed stabiliser.						
081 06 00 00	**LIMITATIONS**						
081 06 01 00	**Operating limitations**						
081 06 01 01	Flutter	x	x				
LO	- Describe the phenomenon of flutter and list the factors: - elasticity. - backlash. - aero-elastic coupling. - mass distribution. - structural properties. - IAS. - List the flutter modes of an aeroplane: - wing. - tailplane.	x	x				

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- fin. - control surfaces including tabs. - Describe the use of mass balance to alleviate the flutter problem by adjusting the mass distribution: - wing mounted pylons. - control surface mass balance. - List the possible actions in the case of flutter in flight.						
081 06 01 02	Aileron reversal	x	x				
LO	- Describe the phenomenon of aileron reversal: - at low speeds - aileron deflection/stall angle relationship. - at high speeds - aileron deflection causing the wing to twist. - Describe the aileron reversal speed in relationship to VNE and VNO.	x	x				
081 06 01 03	Gear/flap operating	x	x				
LO	- Describe the reason for flap/landing gear limitations. - define V_{LO}. - define V_{LE}. - Explain why there is a difference between V_{LO} and V_{LE} in the case of some aeroplane types. - Define V_{FE}. - Describe flap design features to prevent overload.	x	x				
081 06 01 04	V_{MO}, V_{NO}, V_{NE}	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
LO	- Define V_{MO} and V_{NE}. - Describe the difference between V_{MO} and V_{NE}. - Describe the relationship between V_{MO} and V_C. - Define V_{NO}. - Explain the dangers of flying at speeds close to VNE .	x	x				
081 06 01 05	M_{MO}	x					
LO	- Define M_{MO} and state its limiting factors.						
081 06 02 00	**Manoeuvring envelope**						
081 06 02 01	Manoeuvring load diagram	x	x				

LO	- Describe the manoeuvring load diagram.
	- Define limit and ultimate load factor and explain what can happen if these values are exceeded.
	- define VA, VC, VD
	- Identify the varying features on the diagram:
	    - load factor ‘n’.
	    - speed scale, equivalent airspeed, EAS.
	    - C_{LMAX} boundary.
	    - accelerated stall speed refer to 081 01 08 02
	    - V_A
	    - V_C
		x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

Syllabus reference	Syllabus details and associated Learning Objectives	*Aeroplane*		*Helicopter*			*IR*
		ATPL	CPL	ATPL/IR	ATPL	CPL	
	- V_D - State the load factor limits for JAR / CS 23 and 25 aeroplanes in a typical cruise condition and with flaps extended. - Explain the relationship between VA and VS in a formula. - Explain the adverse consequences of exceeding VA and its limitations						
081 06 02 02	Factors affecting the manoeuvring load diagram:	x	x				
LO	- State the relationship of mass to: - load factor limits. - accelerated stall speed limit. - V_A and V_C. - Explain the relationship between V_A, aeroplane mass and altitude. - Calculate the change of V_A with changing mass.	x	x				
LO	- Describe the effect of altitude on Mach number, with respect to limitations. - Explain why V_A loses significance at higher altitude where compressibility effects occur.	**x**					
081 06 03 00	**Gust envelope**						
081 06 03 01	Gust load diagram	x	x				
LO	- Recognise a typical gust load diagram. - Identify the various features shown on the diagram: - gust load factor 'n'. - calculate gust load factor 'n' as a result of increasing angle of attack. - speed scale, equivalent airspeed, EAS.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- C_{LMAX} boundary. - vertical gust velocities. - relationship of V_B to V_C and V_D. - gust limit load factor. - Define $V_{RA.}$ V_B. - Discuss considerations for the selection of this speed. - Explain adverse effects on the aeroplane when flying in turbulence.						
081 06 03 02	Factors affecting the gust load diagram:	x	x				
LO	- Explain the relationship between the gust load factor, lift curve slope, density ratio, wing loading, EAS and equivalent vertical sharp edged gust velocity and perform relevant calculations.	x	x				
081 07 00 00	**PROPELLERS**						
081 07 01 00	**Conversion of engine torque to thrust**						
LO	- Describe thrust and torque load and discuss variation with speed - Explain resolution of aerodynamic force on a propeller blade element into lift and drag or into thrust and torque.	x	x				
081 07 01 01	Relevant propeller parameters	x	x				
LO	- Describe the geometry of a typical propeller blade element at the reference section: - blade chord line. - propeller rotational velocity vector. - true airspeed vector.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- blade angle of attack. - pitch or blade angle. - advance or helix angle. - define geometric pitch, effective pitch and propeller slip. Note: since there are several definitions for geometric pitch throughout Europe, for standardisation purposes the SET 081 uses the following definition for geometric pitch: the theoretical distance a propeller would advance in one revolution at zero blade angle of attack. - define fine and coarse pitch.						
081 07 01 02	Blade twist	x	x				
LO	- Define blade twist. - Explain why blade twist is necessary.	x	x				
081 07 01 03	Fixed pitch and variable pitch/constant speed	x	x				
LO	- List the different types of propeller: - fixed pitch. - adjustable pitch or variable pitch (non-governing). - variable pitch (governing)/constant speed. - Discuss advantages and disadvantages of fixed pitch and constant speed propellers - Discuss climb and cruise propellers. - Explain the relationship between blade angle, blade angle of attack and airspeed for fixed and variable pitch propellers.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Given a diagram, explain the forces acting on a rotating blade element in normal, feathered, windmilling and reverse operation. - Explain the effects of changing propeller pitch on the aeroplane at constant IAS						
081 07 01 04	Propeller efficiency versus speed	x	x				
LO	- Define propeller efficiency. - Explain the relationship between propeller efficiency and speed (TAS). - Plot propeller efficiency against speed for the types of propellers listed in 081 07 01 03 above. - Explain the relationship between blade angle and thrust.	x	x				
081 07 01 05	Effects of ice on propeller	x	x				
LO	- Describe the effects of ice on a propeller.	x	x				
081 07 02 00	**Engine failure or engine stop**						
081 07 02 01	Windmilling drag	x	x				

LO	- List the effects of an inoperative engine on the performance and controllability of an aeroplane:
	  - thrust loss/drag increase.
	  - influence on yaw moment during asymmetric power.
		x	x				

081 07 02 02	Feathering	x	x				
LO	- Explain the reasons for feathering and the effect on performance and controllability. - Influence on yaw moment during asymmetric power.	x	x				
081 07 03 00	**Design feature for power absorption**						

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
LO	- Describe the factors concerning propeller design, which increase power absorption.	x	x				
081 07 03 01	Aspect ratio of blade	x	x				
LO	- Define blade aspect ratio.	x	x				
081 07 03 02	Diameter of propeller	x	x				
LO	- Explain the reasons for restricting propeller diameter.	x	x				
081 07 03 03	Number of blades	x	x				
LO	- Define “solidity”. - Describe the advantages and disadvantages of increasing the number of blades.	x	x				
081 07 03 04	Propeller noise	x	x				
LO	- Explain how propeller noise can be minimised.	x	x				
081 07 04 00	**Moments and couples due to propeller operation**						
081 07 04 01	Torque reaction	x	x				

LO	- Describe the effects of engine/propeller torque.
	- Describe the following methods for counteracting engine/propeller torque:
	  - counter-rotating propellers.
	  - contra-rotating propellers.
		x	x				

081 07 04 02	Gyroscopic precession	x	x				
LO	- Describe what causes gyroscopic precession. - Describe the effect on the aeroplane due to the gyroscopic effect.	x	x				
081 07 04 03	Asymmetric slipstream effect	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
LO	- Describe the possible asymmetric effects of the rotating propeller slipstream.	x	x				
081 07 04 04	Asymmetric blade effect	x	x				
LO	- Explain the asymmetric blade effect. - Explain influence of direction of rotation on critical engine on twin engine aeroplanes.	x	x				
081 08 00 00	**FLIGHT MECHANICS**						
081 08 01 00	**Forces acting on an aeroplane**						
081 08 01 01	Straight horizontal steady flight	x	x				
LO	- Describe the forces acting on an aeroplane in straight horizontal steady flight. - List the four forces and state where they act. - Explain how the four forces are balanced. - Describe the function of the tailplane.	x	x				
081 08 01 02	Straight steady climb	x	x				

LO	- Define γ flight path angle.
	- Describe the relationship between pitch attitude, flight path angle and angle of attack for the zero wind, zero bank and sideslip conditions (note also applicable for horizontal flight and descent)
	- Describe the forces acting on an aeroplane in a straight steady climb.
	- Name the forces parallel and perpendicular to the direction of flight.
	  - Apply the formula relating to the parallel forces ($T = D + W \sin \gamma$).
	  - Apply the formula relating to the perpendicular forces ($L = W \cos \gamma$).
	- Explain why thrust is greater than drag.
		x	x				

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Explain why lift is less than weight. - Explain the formula (for small angles) giving the relationship between flight path angle, thrust, weight and lift/drag ratio and use this formula for simple calculations. - Explain how IAS, angle of attack and flight path angle change in a climb performed with constant pitch attitude and normal thrust decay with altitude.						
081 08 01 03	Straight steady descent	x	x				

LO	- Describe the forces acting on an aeroplane in a straight steady descent.
	- Name the forces parallel and perpendicular to the direction of flight.
	  - Apply the formula parallel to the direction of flight ($T = D - W \sin \gamma$).
	  - Apply the formula relating to the perpendicular forces ($L = W \cos \gamma$).
	- Explain why lift is less than weight.
	- Explain why thrust is less than drag.
	- Explain relationship of Mach number, TAS and IAS during descent at constant Mach number and IAS and explain variation of lift coefficient.
		x	x				

081 08 01 04	Straight steady glide	x	x				

LO	- Describe the forces acting on an aeroplane in a straight steady glide.
	- Name the forces parallel and perpendicular to the direction of flight.
	  - Apply the formula for forces parallel to the direction of flight ($D = W \sin \gamma$).
	  - Apply the formula for forces perpendicular to the direction of flight ($L = W \cos \gamma$).
	- Describe the relationship between the glide angle and the lift/drag ratio.
		x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Describe the relationship between angle of attack and the best lift/drag ratio. - Explain the effect of wind component on glide angle, duration and distance. - Explain the effect of mass change on glide angle, duration and distance. - Explain the effect of configuration change on glide angle, duration and distance. - Describe the relation between TAS and sink rate including minimum glide angle and minimum sink rate.						
081 08 01 05	Steady co-ordinated turn	x	x				
LO	- Describe the forces acting on an aeroplane in a steady co-ordinated turn. - Resolve the forces acting horizontally and vertically during a co-ordinated turn ($\tan\phi = \frac{V^2}{gR}$). - Describe the difference between a co-ordinated and an unco-ordinated turn and explain how to correct an unco-ordinated turn using turn and slip indicator. - Explain why the angle of bank is independent of mass and only depends on TAS and radius of turn. - Resolve the forces to show that for a given angle of bank the radius of turn is determined solely by airspeed ($\tan\phi = \frac{V^2}{gR}$). - Calculate the turn radius, load factor and the time for a complete turn for parameters given for a steady turn. - Discuss effects of bank angle on:	x	x				

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- load factor - angle of attack - thrust - drag - Define angular velocity. - Define rate of turn and rate one turn. - Explain the influence of TAS on rate of turn at a given bank angle.						
081 08 02 00	**Asymmetric thrust**						
LO	- Describe the effects on the aeroplane during flight with asymmetric thrust including both jet engine and propeller driven aeroplanes - Define critical engine, include effect of crosswind when on the ground. - Explain effect of steady asymmetric flight on a conventional (needle, ball) turn and slip indicator.	x	x				
081 08 02 01	Moments about the normal axis	x	x				
LO	- Describe the moments about the normal axis. - Explain the yawing moments about the cg. - Describe the change to yawing moment caused by power changes. - Describe the changes to yawing moment caused by engine distance from cg. - Describe the methods to achieve balance.	x	x				
081 08 02 02	Forces on vertical fin	x	x				
LO	- Describe the forces acting on the fin.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Describe the side force on the fin which counteracts the aeroplane yawing moment about the cg. - Resolve the aeroplane yawing moment and fin side force by simple calculation.						
081 08 02 03	Influence of bank angle	x	x				
LO	- Describe the influence of bank angle on yawing moment. - Explain the effect on fin side force when the aeroplane is banked towards the live engine. - Explain why the bank angle must be limited. - Explain the effect on fin angle of attack due to sideslip.	x	x				
081 08 02 04	Influence of aeroplane mass	x	x				
LO	- Describe the effect of mass increase. - Describe how mass increase will increase the yawing moment. - Describe the effect on sideslip with mass increase. - Describe the effect on rudder effectiveness.	x	x				
081 08 02 05	Influence of use of ailerons	x	x				
LO	- Describe the influence of ailerons. - Explain why aileron effectiveness is reduced.	x	x				
081 08 02 06	Influence of special propeller effects on roll moments	x	x				
LO	- Describe the effect on roll moment created by propeller effect. - Explain the influence of torque reaction. - Explain the influence of flaps on roll moment.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
081 08 02 07	Influence of sideslip angle on roll moments	x	x				
LO	- Describe the influence of sideslip angle on roll moments. - Explain how sidelip angle changes the C_L of the left and right wings.	x	x				
081 08 02 08	V_{MCA}	x	x				
LO	- Define V_{MCA}. - Describe how V_{MCA} is determined. - Explain influence of cg location.	x	x				
081 08 02 09	V_{MCL}	x	x				
LO	- Define V_{MCL}. - Describe how V_{MCL} is determined. - Explain influence of cg location.	x	x				
081 08 02 10	V_{MCG}	x	x				
LO	- Define V_{MCG}. - Describe how V_{MCG} is determined. - Explain influence of cg location.	x	x				
081 08 02 11	Influence of altitude and temperature	x	x				
LO	- Describe the influence of altitude and temperature. - Explain why VMCA and VMCG reduces with an increase in altitude and temperature.	x	x				
081 08 03 00	**Emergency descent**	x	x				
LO	- Describe low and high speed emergency descent.	x	x				

CHAPTER 17: DETAILED THEORETICAL KNOWLEDGE SYLLABUS AND LEARNING OBJECTIVES
Subject – 081 – Principles of Flight (Aeroplane)
See Appendix 1 to JAR-FCL 1.470 and JAR-FCL 2.470

		Aeroplane		*Helicopter*			*IR*
Syllabus reference	**Syllabus details and associated Learning Objectives**	ATPL	CPL	ATPL/IR	ATPL	CPL	
	- Explain the advantages and disadvantages of low and high speed emergency descent.						
081 08 03 01	Influence of configuration	x	x				
LO	- Describe the influence of configuration on emergency descent. - Describe the methods to increase drag.	x	x				
081 08 03 02	Influence of chosen IAS	x	x				
LO	- Explain why indicated airspeed is the limiting speed at low level. - Describe the dangers when recovering from emergency descent.	x	x				
081 08 03 03	Influence of chosen Mach number	x					
LO	- Explain why MMO is the limiting speed at altitude.	x					
081 08 04 00	**Typical points on polar curve**						
LO	- Identify the typical points on a polar curve and explain their significance, assuming a parabolic approximation	x	x				
081 08 05 00	**Wind shear**						
LO	- Effect on take-off and landing. - Describe the influence of increasing and decreasing windspeed. - Describe a typical recovery from windshear.	x	x				