AIRLINE TRANSPORT PILOTS LICENSE

(080 00 00 00 - PRINCIPLES OF FLIGHT)

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 01 00 00	**SUBSONIC AERODYNAMICS**	
081 01 01 00	**Basics, Laws and Definitions**	
081 01 01 01	– **Laws and definitions**	
	– List the SI-units for mass, acceleration, velocity, density, temperature, pressure, force, wing loading and power	
	– Describe Newton´s Laws	
	– Describe Newton´s first law of continuity	
	– Describe Newton’s second law (law of motion)	
	– Describe the equation of momentum (impulse), 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	Given table of Standard Atmosphere
	– Apply the formula for a given altitude and speed	
	– Define Bernoulli´s theorem	
	– Define total pressure	Given table of Standard

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	– Apply the theorem for a given speed and altitude	Atmosphere
	– Apply the theorem 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 the speed of sound and its symbol	
	– Describe how atmospheric properties affect the speed of sound	
	– Define IAS, CAS, EAS, TAS and MACH number	
081 01 01 02	– **Basics about airflow**	
	– Describe stationary and not stationary airflow	
	– Explain the concept of a streamline	
	– Describe and explain airflow through a streamtube	
	– Explain the difference between two and three dimensional airflow	
081 01 01 03	– **Aerodynamic forces and moments on the surfaces**	
	– 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	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
	– Define the aerodynamic moment	
	– List the factors that affect the aerodynamic moment	
	– Describe the aerodynamic moment for a symmetrical aerofoil.	
	– Describe the aerodynamic moment for a positively cambered aerofoil.	
	– Forces and equilibrium of forces Refer 081 08 00 00	
	– Define angle of attack	
081 01 01 04	– **Shape of an aerofoil**	
	– Describe the following parameters of an aerofoil:	
	– Leading edge	
	– Trailing edge	
	– Chordline	
	– Thickness to chord ratio	
	– Location of maximum thickness	
	– Camberline	
	– Camber	
	– Nose radius	
	– Angle of attack	
	– Angle of incidence	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Describe a symmetrical and an asymmetrical aerofoil	
081 01 01 05	– **The wing shape** – Describe the following parameters of a wing: – Span – Root chord – Tip chord – Taper ratio – Wing area – Mean aerodynamic chord MAC – Aspect ratio – Dihedral angle	
081 01 02 00	**The Two-dimensional Airflow about an aerofoil**	
081 01 02 01	– **Describe the streamline pattern over an aerofoil** – Describe converging and diverging streamlines and their effect on static pressure and velocity – Describe up-wash and down-wash	
081 01 02 02	– **Stagnation point** – Describe the stagnation point	

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	– Explain the effect on the stagnation point of angle of attack changes.	
	– Explain local pressure changes.	
081 01 02 03	– **Pressure distribution**	
	– Describe an approximate pressure distribution over an aerofoil	
	– Describe where the minimum local static pressure is typically situated on an aerofoil	
081 01 02 04	– **Centre of pressure and aerodynamic centre**	
	– Define the centre of pressure and aerodynamic centre.	
	– Explain centre of pressure movement with angle of attack.	
081 01 02 05	– **Lift and downwash**	
	– Explain the association between lift and downwash	
081 01 02 06	– **Drag and wake**	
	– 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)	
081 01 02 07	– **Explain the influence of angle of attack on lift**	
081 01 02 08	– **Refer 081 01 08 01**	
081 01 02 09	– **Describe the lift and angle of attack graph**	Given lift - α graph

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
	– Explain the significant points on the graph. – Describe lift against α graph for a symmetrical profile	
081 01 03 00	**The Coefficients** – Explain why coefficients are used in general	
081 01 03 01	– **The lift coefficient C_L** – Describe the lift formula – List factors that influence lift – Describe which are the dominant factors in the lift formula – Describe the C_L - α graph (symmetrical and positively cambered profile - Describe the typical difference in C_L - α graph for fast and slow profile design – Define the C_{Lmax} and α_{stall} on the graph – State the approximate stall angle of attack	
081 01 03 02	– **The drag coefficient C_D** – Describe the drag formula – List the factors that influence drag – Indicate which is the dominant factor in the drag formula – State that drag increases as a function of the square of the speed – State that drag is proportional to the density of the airflow	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Describe the C_L - C_D graph – 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	
081 01 04 00	**The Three-dimensional Airflow about an Aeroplane** – Explain the difference between the angle of attack and the attitude of an aeroplane	
081 01 04 01	– **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 up-wash and down-wash due to tip vortices – Describe span-wise lift distribution – Describe the causes, distribution and duration of the wake turbulence behind an aircraft – Describe the influence of flap deflection on the tip vortex – List the parameters that influence the wake turbulence	
081 01 04 02	– **The Induced Drag** – Explain what causes the induced drag	

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JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS

	– 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 weight on induced drag at a given IAS
	– Describe the design means to decrease induced drag
	    – Winglets
	    – Tip tanks
	    – Wing span loading
	    – Influence of wing twist
	    – Influence of camber change
	– Describe the influence of tip vortices on the angle of attack.
	– Explain induced 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
	– Explain the induced drag coefficient.	

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	– 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
	  – 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** – Explain how lift affects drag	

081 01 05 01	– **The parasite drag**
	– List the types of drag that are included in the parasite drag
	  – Describe profile drag.
	  – Describe interference drag.
	  – Describe friction drag	

081 01 05 02	– **The parasite drag and speed** – Describe the relationship between parasite drag and speed.	
081 01 05 03	– **Refer 081 01 04 02**	
081 01 05 04	– **The total drag**	
081 01 05 05	– **Describe total drag - IAS graph**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 01 05 06	– **Indicate the IAS for the minimum drag from the graph**	
081 01 05 07	– **The drag - speed graph** – Describe the effect of aeroplane gross weight 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 on the non-stable region if speed suddenly decreases	
081 01 06 00	**The Ground Effect** – **Explain what happens to the tip vortices, down-wash, airflow pattern and lift vector close to the ground.**	
081 01 06 01	– **Describe the influence of the ground effect on C_{DI}** – Explain the effects on entering and leaving the ground effect	
081 01 06 02	– **Describe the influence of the ground effect on α_{stall}**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 01 06 03	– **Describe the influence of the ground effect on C_L**	
081 01 06 04	– **Describe the influence of the ground effect on take-off and landing characteristics of an aeroplane** – 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	**Describe the relationship between lift coefficient and speed for constant lift as a formula**	
081 01 07 01	– **Explain the effect on C_L during speed increase/decrease in level flight.**	
081 01 07 02	– **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** – 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	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
	– Define the transition	
	– 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	
	– Define the critical or stalling 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	
	– C_L and L	
	– C_D and D	
	– The pitching moment (straight and swept back wing)	
	– The down-wash at 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	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 01 08 02	– **The stall speed**	
	– Solve the 1g stall speed from the lift formula	Given the formula with
	– Define the FAA stall speed	V_S and C_{Lmax} .
	– Describe and explain the Influence of the following parameters on the stall speed:	
	– Centre of gravity	
	– Power setting	
	– Wing loading (W/S) or gross mass	
	– Wing contamination	
	– Angle of sweep	
	– Define the load factor n	
	– Describe the general idea why the load factor increases in turns	
	– Describe and explain the Influence of the load factor (n) on the stall speed	
	– Calculate the increase of stall speed as a function of the load factor	
	– Calculate the increase of stall speed in a horizontal coordinated turn as a function of bankangle	
	– Calculate the change of stall speed as a function of the gross weight	
081 01 08 03	– **The initial stall in span-wise direction**	
	– Explain the initial stall sequence on the following planforms	
	– Elliptical	

JAR-FCL REF NO	**LEARNING OBJECTIVES**	REMARKS
	– 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.	
081 01 08 04	– **Stall warning**	

	– Explain why stall warning is necessary
	– Explain when aerodynamic and artificial stall warnings are used
	– Explain why JAR 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
	  – Stick shaker
	– Describe warnings of:	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– high speed buffet	
	– Describe the recovery after:	
	– stall warning	
	– stall	
	– stick pusher actuation	
081 01 08 05	– **Special phenomena of stall**	
	– Describe the basic stall requirements for JAR/ 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 stalling and recovery characteristics on:	
	– Swept back wings	
	– 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	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Describe and explain the stabiliser stall – Describe when to expect in-flight-icing – 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 hold/overtime 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 aircraft that have different mass distributions between the wing and the fuselage	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 01 09 00	**C_{LMAX} Augmentation**	
081 01 09 01	– **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	
	– Fowler flaps	
	– Describe their effect on wing geometry	
	– Describe how the wings effective camber increases	
	– Describe how the effective chordline differs from the normal chordline	
	– Describe their effect on the stalling 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 stalling angle of attack	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– 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 deflection on glide angle	
	– Describe flap asymmetry	
	– Explain the effect on aircraft controllability	
	– Describe trailing edge flap effect on take-off and landing	
	– Explain the advantages of lower nose attitudes	
	– Explain why take-off and landing speeds/distances are reduced	
081 01 09 02	– **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	

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	- Describe how the wings effective camber increases
	    – Describe how the effective chordline differs from the normal chordline
	  – State their effect on the stalling speed
	  – Compare their influence on the C_L - α graph, compared trailing edge flaps and 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 angle of attack
	  – Compare their influence on the C_L - C_D graph
	  – Describe slat asymmetry
	    – Describe the effect on aeroplane controllability
	  – Describe automatic slat operation
	  – 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**
	  – Explain the purpose of vortex generators
	  – Describe their basic operating principle
	  – State their advantages and disadvantages	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
080 01 10 00	**Means to Decrease the C_L/C_D Ratio, and Increase Drag**	
081 01 10 01	– **Describe spoilers 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	
	– Describe the influence of spoilers on the C_L - C_D graph and lift/drag ratio	
081 01 10 02	– **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 of descent	
081 01 11 00	**Boundary Layer**	
081 01 11 01	– **Refer 081 01 08 01**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 01 11 02	– **Advantages and disadvantages of different types of boundary layer on pressure drag and friction drag**	
081 01 12 00	**Special Circumstances**	
081 01 12 01	– **Explain the effect of ice and other contamination on aeroplane performance** – Describe the effects of ice accumulations at the stagnation point – Describe the effects on 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 the effect on aircraft weight – Explain the effect on lift and drag – Describe the effect of contamination of the leading edge – Explain the effect on aircraft 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 stalling angle of attack	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Describe the effect on the stalling speed – Describe how contamination leads to loss of controllability – State the effect of tail icing – 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	– **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 aircraft	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 02 00 00	**TRANSONIC AERODYNAMICS**	
081 02 01 00	**The Mach number definition**	
081 02 01 01	– **Define the speed of sound**	
	– **Define the Mach number as a function of TAS and speed of sound**	
081 02 01 02	– **Describe the influence of temperature on the speed of sound**	
	– **Explain the variation of the speed of sound with altitude**	
	– **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.**	
081 02 01 03	– **State that compressibility means that density can change along a streamline**	
	– State that Mach number is a measure of compressibility	
081 02 02 00	**Normal shockwaves**	Give the approximate boundaries in Machnumber values
	– **List the subdivision of aerodynamic flow:**	
	– Subsonic flow	
	– Low-subsonic, non-compressible flow	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– High subsonic, compressible flow	
	– Transonic flow, mixture of local speeds above and below the speed of sound	
	– Supersonic flow, all speeds higher than the speed of sound	
081 02 02 01	– **Describe how the streamline pattern changes due to compressibility.**	
	– **Describe M_{crit}**	
	– **Describe a normal shock wave in a transonic flow with respect to**	
	– temperature, pressure, velocity and density changes	
	– location in a supersonic area of the stream pattern	
	– length of the shockwave and orientation relative to the wing surface	
081 02 02 02	– **Explain the influence of increasing Mach on a normal shock wave, at positive lift with respect to**	
	– strength	
	– position relative to the wing	
	– second shock wave at the lower surface	
	– **Explain the influence of control surface deflection with respect to**	
	– the effect of M_{crit}	
	– loss of control effectiveness	
	– **Explain how increase of the angle of attack influences normal shock wave and M_{crit}**	
	– **Explain the effect of aerofoil thickness on M_{crit}**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– **Explain the influence of the angle of sweep with respect to**	
	– the increase of M_{crit}	
	– effective thickness/chord change.	
	– velocity component perpendicular to the leading edge.	
	– **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.	
	– **Explain area ruling in aeroplane design**	
081 02 02 03	– **Describe the consequences of exceeding M_{crit} with respect to**	
	– gradient of the C_L-α graph	
	– C_{LMAX} (stall speed)	
	–	
	– **Explain the behaviour of C_D versus M at constant angle of attack**	
	– **Explain effect of Mach number on the C_L-C_D graph**	
081 02 02 04	– **State that aerodynamic heating is caused by compression and friction.**	
081 02 02 05	– **Explain shock stall and describe its relationship with mach buffet.**	
081 02 02 06	– **Describe the influence on:**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Wave drag	
	– **Explain the influence of shock stall on the location of the centre of pressure with respect to**	
	– loss of lift at the wing root	
	– reduction of downwash at the wing root	
	– **List the aerodynamic and mechanical counter measures for the Mach tuck-under effect**	
081 02 02 07	– **Describe the influence on the buffet margin of**	
	– angle of attack	
	– Mach number	
	– pressure altitude	
	– mass	
	– load factor	
	– **Describe the 1.3 g altitude with respect to the buffet margin**	
	– **Describe what can be obtained from the buffet boundary chart**	Given a Buffet Onset Boundary Chart of the Airbus A310
	– **Find:**	
	– 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	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– **Illustrate the behaviour of the buffet margin when an aeroplane is descending or ascending at a given indicated airspeed, or Mach number.**	

081 02 02 08	– **Identify the V_{MO} and M_{MO} values**
	– **Identify the stall speed**
	– **Identify the "coffin corner"**
	– **Describe**
	  – the allowable speed range in the coffin corner
	  – the influence of mass on the coffin corner boundaries
	  – the consequences of exceeding V_{MO}
	  – the consequences of exceeding M_{MO}
	– **Describe the influence of**
	  – buffet on the flight envelope
	  – mass on the values of V_{MO} and M_{MO}
	  – temperature on the pressure altitude at which the V_{MO} limit intersects the M_{MO} limit
		Given a flight envelope diagram of the Airbus A310

081 02 03 00	**Means to avoid the effects of exceeding M_{crit}**	
081 02 03 01	– **Explain the use of vortex generators as a means to avoid or restrict flow separation**	
081 02 03 02	– **Identify the following shape characteristics of a supercritical aerofoil shape:** – Blunt nose	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Large thickness – S-shaped camber line – Flat upper surface – Thick trailing edge	
	– **Explain with respect to a supercritical aerofoil**	
	– the increased number of smaller and weakened shockwaves compared those of a classic profile – the absence of a strong influence on M_{crit} – aft loading	
	– **Explain the following advantages of a supercritical aerofoil:**	
	– allows use of less sweep angle – may be built lighter, due to greater thickness – allows storage of more fuel – allows use of a higher aspect ratio	
	– **Explain the following disadvantages of a supercritical aerofoil:**	
	– Negative camber at the aerofoil front side – Buffet may cause severe oscillations	
081 03 00 00	**SUPERSONIC AERODYNAMICS**	
081 03 01 00	**Oblique Shockwaves**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 03 01 01	– **Define Mach Cone**	
	– **Explain that the Mach cone top angle decreases with increasing Mach number**	
	– **Define the bow wave**	
	– **Identify the Mach cone area of influence of a pressure disturbance due to the presence of the aeroplane**	
	–	
	–	
081 03 01 02	– **Describe influence of weight (wing loading)**	
081 03 01 03	– **Describe shock waves and expansion waves with respect to the streamline pattern and variation of pressure, temperature, density and velocity along a streamline**	
	– **Describe the velocity behind a normal and an oblique shockwave**	
081 03 01 04	– **Describe the movement of the centre of pressure with increasing Mach number**	
	– **Describe the pressure distribution in chord direction in supersonic flight**	
081 03 01 05	– **Describe wave drag**	
	– **Describe effect on control surface hinge moment**	
	– **Describe effect on control surface efficiency**	
	– **Explain that an oblique shockwave moves with aeroplane ground speed over the earth surface**	
081 04 00 00	**STABILITY**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 04 01 00	**Condition of equilibrium in stable horizontal flight**	
081 04 01 01	– **Explain an equilibrium of forces and moments as the condition for the concept of static stability**	
	– **Identify**	
	– Longitudinal static stability	
	– Directional static stability	
	– Lateral static stability	
081 04 01 02	– **Identify the moments considered in the equilibrium of moments: moments about all three axes**	
081 04 01 03	– **Identify the forces considered in the equilibrium of forces**	
081 04 02 00	**Methods of achieving balance**	
081 04 02 01	– **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**	
081 04 02 02	– **Explain the use of the elevator deflection or stabiliser angle for the generation of the balancing force**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– **Explain the elevator deflection required to balance thrust changes**	
081 04 02 03	– **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**	
081 04 03 00	**Longitudinal Stability**	
081 04 03 01	– **Define static stability**	
	– **Identify a statically stable, neutral and unstable equilibrium**	
	– **Define dynamic stability**	
	– **Identify a dynamically stable, neutral and unstable 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 and damping**	
	– **Explain that during the phugoid motion the angle of attack remains approximately constant**	
	– **Explain that during the short period motion the aircraft speed remains approximately constant**	
	– **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**	
081 04 03 02	– **Explain why static stability is the opposite of manoeuvrability**	
081 04 03 03	– **Neutral point / location of neutral point**	

AIRLINE TRANSPORT PILOTS LICENSE

(080 00 00 00 - PRINCIPLES OF FLIGHT)

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– **Define neutral point**	
	– **Explain why the location of the neutral point is only dependent on the aerodynamic design of the aeroplane**	
081 04 03 04	– **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**	
081 04 03 05	– **Explain the influence of the location of the centre of gravity on static and dynamic stability of the aeroplane**	
	– **Explain the approved forward and aft limits of the centre of gravity with respect to the criteria of control forces, elevator effectiveness and stability**	
	– **Define the minimum stability margin**	
081 04 03 06	– **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	
081 04 03 07	– **Explain**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– 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	
	–	
081 04 03 08	– **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	
081 04 03 09	– **Explain the contribution on the elevator position - speed graph of:**	
	– Location of centre of gravity.	
	– Trim (trim tab and stabiliser trim)	
	– high lift devices	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 04 03 10	– **Define the stick force speed graph** – **Describe the minimum gradient for stick force versus speed that is required for certification according JAR 23 and JAR 25** – **Explain the importance of the stick force gradient for good flying qualities of an aeroplane** – **Identify the trim speed in the stickforce speed graph**	

081 04 03 11	– **Explain the contribution of:**
	  – Location of the centre of gravity
	  – Trim (trim tab and stabiliser trim)
	  – Mach number and the effect of Mach tuck-under and the Mach trim system
	  – Downspring
	  – bob weight
	  – friction
	– **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	

081 04 03 12	– **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	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 04 03 14	– **Explain that the stickforce per g is:**	
	– dependent on location of centre of gravity	
	– 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	– **Explain why the prescribed minimum and maximum values of the stickforce per g are dependent on the limit load factor**	
	– **Calculate the stick force to achieve a certain load factor at a given manoeuvre stability**	
081 04 03 16	– **Refer to 081 05 02 03**	
081 04 04 00	**Static directional stability**	
081 04 04 01	– **Define slip angle**	
	– **Identify β as the symbol used for the slip angle**	
081 04 04 02	– **Define the yawing moment coefficient C_N**	
	– **Define the relationship between C_N and β for an aeroplane with static directional stability**	
081 04 04 03	– **Explain why**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– C_N depends on the angle of slip – C_N equals zero for that angle of slip that provides static equilibrium about the aircrafts normal axis – If no asymmetric engine thrust, flight control or loading condition prevails, the equilibrium angle of slip equals zero – **Identify how the slope of the C_N-β graph is a measure for static directional stability:**	
081 04 04 04	– **Describe how the following aircraft components contribute to static directional stability.** – Wing – Fin – Dorsal fin – Ventral fin – Angle of sweep of the wing – Angle of sweep of the fin – location of centre of gravity – fuselage at high angles of attack – strakes – **Explain why both the fuselage and the fin contribution reduce static directional stability after an aft shift of the centre of gravity**	
081 04 05 00	**Static lateral stability**	
081 04 05 01	– **Define bank angle phi**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 04 05 02	– **Define the rolling moment coefficient C_l**	
081 04 05 03	– **Explain how without co-ordination, the bank angle creates slip angle**	
081 04 05 04	– **Describe C_l-β graph**	
	– **Identify the slope of the C_l-β graph as a measure for static lateral stability**	
081 04 05 05	– **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	
081 04 05 06	– **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)	
081 04 06 00	**Dynamic lateral/directional stability**	
081 04 06 01	– **Effects of asymmetric propeller slipstream**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 04 06 02	– **Explain how lateral and directional stability are coupled** – **Explain how high static directional 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**	
081 04 06 03	– **Describe Dutch roll** – **Explain** – why Dutch roll occurs when the dihedral effect 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	
081 04 06 04	– **Explain that increased pressure altitude reduces dynamic lateral/directional stability**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 05 00 00	**CONTROL**	
081 05 01 00	**General**	
081 05 01 01	– **Basics**	
	– Define	
	– Lateral axis	
	– Longitudinal axis	
	– Normal axis	
	– Describe the motion about the three axes	
	– Name and describe the devices that control these motions	
081 05 01 02	– **Camber change**	
	– Explain how camber is changed by movement of a control surface	
081 05 01 03	– **Angle of Attack change**	
	– Explain the influence of local angle of attack change by movement of a control surface	
081 05 02 00	**Pitch Control**	
081 05 02 01	– **Elevator/all flying tail**	
	– Explain the working principle of the horizontal tailplane (stabilizer)	
	– Explain the working principle of the elevator and describe its function.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– 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, at higher than normal speed.	
081 05 02 02	– **Downwash effects** – Explain the effect of downwash on the tailplane angle of attack. – Explain in this context the use of a T-tail or stabilizer trim.	
081 05 02 03	– **Ice on tail** – Explain how ice can change the aerodynamic characteristics of the tailplane. – Explain how this can affect the tails proper function	
081 05 02 04	– **Location of centre of gravity** – Explain the relationship between pitching moment coefficient and lift coefficient – Explain the relationship between elevator deflection and location of c.g. in straight flight and in a g manoeuvre	
081 05 03 00	– **Directional control** – 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	
081 05 03 01	– **Pedal/Rudder ratio changer**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Describe the purpose of the rudder ratio changer.	
081 05 03 02	– **Moments due to engine thrust**	
	– Describe the effect of engine thrust on pitching moments	
	– Explain fin stall due to rudder displacement	
081 05 03 03	– **Engine failure**	
	– **Refer 081 08 02 00**	
081 05 04 00	**Roll control**	
081 05 04 01	– **Ailerons**	
	– Describe the purpose of the ailerons	
	– Describe the adverse effects of ailerons.	
	– 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 side slip, cross wind landings, horizontal turns, flight with one engine out.	
	– Define roll rate	
	– List the factors that effect roll rate	
	– Flaperons, aileron droop	
081 05 04 03	– **Spoilers**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Explain how spoilers affect lift	
	– Explain how spoilers can be used to control the rolling movement in combination with or instead of the ailerons	
081 05 04 04	– **Adverse yaw**	
	– Explain how the use of ailerons induce adverse yaw	
081 05 04 05	– **Means to avoid adverse yaw**	
	– Explain how the following reduce adverse yaw	
	– Frise ailerons	
	– Differential ailerons deflection	
	– Coupling aileron deflection	
	– Roll spoilers	
	– effects of asymmetric propeller slipstream	
081 05 05 00	– **Interaction in different planes (yaw/roll)**	
	– Describe the coupling effect of roll and yaw	
	– Explain the secondary effect of ailerons	
	– Explain the secondary effect of rudder	
081 05 05 01	– **Limitations of asymmetric power**	
	– **Refer to 081 08 02 06**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 05 06 00	**Methods of Reducing Control Forces**	
081 05 06 01	– **Aerodynamic balance** – 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	
081 05 06 02	– **Artificial means** – List the examples of artificial means of assisting aerodynamic force – Describe fully powered controls – Describe power assisted controls – Explain why artificial feel is required – Explain how artificial feel is produced (inputs) – Dynamic pressure – Stabilizer setting	
081 05 07 00	**Mass Balance**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	Refer 081 06 01 00	

081 05 08 00
 	
081 05 08 01
 	
081 05 08 02
081 05 08 03
	Trimming
	
	– **Reasons for trimming**
	  – State the reasons for trimming devices.
	– **Describe the working principle of a trim tab**
	– **Describe stabilizer trim/trim rate verses IAS**
	  – Explain the advantages of a stabiliser trim versus a trim tab
	  – Explain elevator deflection when aeroplane is trimmed for fully powered and power assisted pitch controls
	  – Explain the cg position influence on the stabiliser setting
	    – In-flight
	    – Take-off
	    – Explain the influence of take-off stabiliser trim setting on stick force during rotation at varying c.g. positions within the allowable c.g. range	

081 06 00 00	**Limitations**	
081 06 01 00	**Operating Limitations** – **Describe the phenomenon of flutter, and list the factors** – Elasticity	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Backlash – Aero-elastic coupling – Mass distribution – **List the flutter modes of an aeroplane** – Wing – Tailplane – 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** – **Describe the phenomenon of aileron reversal** – At low speeds - aileron deflection/stalling angle relationship – At high speeds - aileron deflection causing the wing to twist – Describe the aileron reversal speed in relationship to V_{NE} and V_{NO}	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
080 06 01 01	– **Describe the reason for flap/landing gear limitations** – V_{LO} – 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 – **V_{MO}, V_{NO}, V_{NE}** – Define V_{MO} and V_{NE} – Describe the difference between V_{MO} and V_{NE} – Describe the relationship between V_{MO} and V_C	
081 06 01 02	– Define V_{NO} – Explain that V_{MO} can be exceeded during a descent at constant Mach number – **M_{MO}** – Define M_{MO} and state its limiting factors – Explain that M_{MO} can be exceeded during a climb at constant IAS	
081 06 02 00	**Manoeuvring Envelope**	Given an example diagram

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 06 02 01	– **Describe the manoeuvring load diagram** – Identify the varying features on the diagram – Load factor ‘n’ – Speed scale, equivalent airspeed, EAS – C_{Lmax} boundary – V_A design manoeuvring speed – V_C design cruising speed – V_D design dive speed, a speed set sufficient above V_C to allow for the effects of a defined ‘upset’ – State the load factor limits for JAR 23 and 25 aircraft in a typical cruise condition and with flaps extended	
081 06 02 02	– **Contribution of mass, altitude and mach number** – State the relationship of mass to – Load factor limits – Accelerated stall speed limit – V_A, V_B and V_C – Explain the relationship between V_A and aeroplane mass – Explain the relationship between V_A and V_S in a formula – Calculate the change of V_A wih changing weight – Describe the effect of altitude on mach number, in respect to limitations	
081 06 03 00	**Gust Envelope**	Given example diagram

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 06 03 01	– **Gust Load Diagram**	
	– Recognise a typical gust load diagram	
	– Identify the various features shown on the diagram	
	– Load factor ‘n’	
	– Calculate n as a result of increasing angle of attack.	
	– Speed scale, equivalent airspeed, EAS	
	– $C_{L\ MAX}$ boundary	
	– Vertical gust velocities	
	– Relationship of V_B to V_C and V_D	
	– Gust limit load factor	
	– Define V_{RA}	
081 06 03 02	– **Contribution of mass, altitude, speed, mach number, aspect ratio and wing sweep**	
	– Explain the relationship between mass, altitude, speed, mach number, aspect ratio and wing sweep on gust loads	
081 07 00 00	**Propellers**	
081 07 01 00	**Conversion of engine torque to thrust**	Given diagram
	– **Describe thrust and torque load**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 07 01 01	– **Meaning of pitch**	
	– Describe the geometry of a typical propeller blade element at a representative span location	
	– Blade chord line	
	– Propeller rotational velocity vector	
	– True airspeed vector	
	– Blade angle of attack	
	– Pitch or blade angle	
	– Advance or helix angle	Given diagram
081 07 01 02	– **Blade twist**	
	– Explain why blade twist is necessary	
	–	
081 07 01 03	– **Fixed pitch and variable pitch/constant speed**	
	– List the different types of propeller	
	– Fixed pitch	
	– Adjustable pitch or variable pitch (non-governing)	
	– Variable pitch (governing)/constant speed	
	– Explain the relationship between blade angle, blade angle of attack and speed for constant speed propeller and a fixed pitch propeller	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 07 01 04	– **Propeller efficiency versus speed**	
	– Define propeller efficiency	
	– Explain the relationship between propeller efficiency and speed (TAS)	Given diagram
	– 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	
081 07 01 05	– **Effects of ice on a propeller**	
	– Describe the effects of ice on a propeller	
081 07 02 00	**Engine Failure or Engine Stop (shut-down)**	
081 07 02 01	– **Windmilling drag**	
	– **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	
081 07 02 02	– **Feathering**	
	– Explain the reasons for feathering and the effect on performance and controllability	
	– influence on yaw moment during asymmetric power	
081 07 03 00	**Design features for power absorption**	
	– Describe the factors concerning propeller design which increase power absorption.	
081 07 03 01	– **Propeller blade aspect ratio**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Define blade aspect ratio	
081 07 03 02	– **Propeller blade diameter**	
	– Explain the reasons for restricting propeller diameter	
081 07 03 03	– **Number of propeller blades**	
	– Define ”solidity”.	
	– Describe the advantages and disadvantages of increasing the number of blades	
081 07 03 04	– **Propeller noise**	
	– Explain how propeller noise can be minimized	
081 07 04 00	**Moments and couples due to propeller operation**	
081 07 04 01	– **Torque reaction**	
	– Describe the following methods for counteracting engine torque	
	– Counter-rotating propellers	
	– Contra-rotating propellers	
081 07 04 02	– **Gyroscopic precession**	
	– Describe the effect on the aeroplane due to the gyroscopic effect	
081 07 04 03	– **Asymmetric slipstream effect**	
	– Describe the possible asymmetric effects of the rotating propeller slipstream	
081 07 04 04	– **Asymmetric blade effect**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Describe the asymmetric blade effect	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 08 00 00	**FLIGHT MECHANICS**	
081 08 01 00	**Forces Acting on an Aeroplane**	
081 08 01 01	– **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	
081 08 01 02	– **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 q)	
	– Apply the formula relating to the perpendicular forces (L = W cos q)..	
	– Explain why thrust is greater than drag.	
	– Explain why lift is less than mass.	
081 08 01 03	– **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 q).	
	– Apply the formula relating to the perpendicular forces (L = W cos q).	
	– Explain why lift is less than mass.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Explain why thrust is less than drag.	
081 08 01 04	– **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 ($D = W \sin q$)	
	– Apply the formula for forces perpendicular to the direction of flight ($L = W \cos q$)	
	– Describe the relationship between the glide angle and the lift/drag ratio.	
	– Describe the relationship between angle of attack and the best lift/drag ratio.	
	– Explain the effect on glide angle with a wind component.	
	– Explain the effect on glide angle with mass change.	
081 08 01 05	– **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 ($\tan f = \frac{V^2}{gr}$)	
	– Explain how to correct an unco-ordinated turn	
	– Explain why the angle of bank is independent of weight 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 ($\tan f = \frac{V^2}{gr}$)	
	– Calculate the turn radius at a given angle of bank and TAS	
	– Explain why the load factor is greater than one in a co-ordinated turn.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Calculate the lift increase as a function of the bank angle – 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	**Describe the Effects on the Aeroplane During Flight with Asymmetric Thrust** – Define critical engine	
081 08 02 01	– **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	
081 08 02 02	– **Describe the forces acting on the fin.** – Describe the side force on the fin which counteracts the aircraft yawing moment about the cg. – Resolve the aircraft yawing moment and fin side force by simple calculation. –	
081 08 02 03	– **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.	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
	– Explain the effect on fin angle of attack due to side-slip.	
	–	
081 08 02 04	– **Describe the effect of weight increase.**	
	– Describe how weight increase will increase the yawing moment.	
	– Describe the effect on side-slip with weight increase.	
	– Describe the effect on rudder effectiveness.	
081 08 02 05	– **Describe the influence of ailerons.**	
	– Explain why aileron effectiveness is reduced.	
081 08 02 06	– **Describe the effect on roll moment created by propeller effect.**	
	– Explain the influence of torque reaction.	
	– Explain the influence of flaps on roll moment.	
081 08 02 07	– **Describe the influence of slip angle on roll moments.**	
	– Explain how slip angle changes the C_L of the left and right wings.	
	–	
081 08 02 08	– **Define V_{MCA}**	
	– Describe how V_{MCA} is obtained	
081 08 02 09	– **Define V_{MCL}**	
	– Describe how V_{MCL} is obtained	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 08 02 10	– **Define V_{MCG}**	
	– Describe how V_{MCG} is obtained.	
081 08 02 11	– **Describe the influence of altitude.**	
	– Explain why V_{MCA} and V_{MCG} reduces with an increase in altitude.	
	– Explain the significance of power/thrust available and power/thrust required.	
	– Derive the effect on rate of climb and angle of climb.	
081 08 03 00	**Emergency descent**	
	– Describe low and high speed emergency descent	
	– Explain the advantages and disadvantages of low and high speed emergency descent	
081 08 03 01	– **Describe the influence of configuration on emergency descent**	
	– Describe the methods to increase drag	
	–	
081 08 03 02	– **Influence of chosen mach number and IAS**	
	– Explain why M_{MO} is the limiting speed at altitude	
	– Explain why indicated airspeed is the limiting speed at low level	
	– Describe the dangers when recovering from emergency descent	
081 08 03 03	– **Identify the typical points on a polar curve**	

JAR-FCL REF NO	LEARNING OBJECTIVES	REMARKS
081 08 03 04	– **Windshear** – Effect on take-off and landing – Describe the influence of increasing and decreasing windspeed – Describe a typical recovery from windshear	