Introduction to Aircraft Design
July-2023

Assignment 7

Q 1	Which of the following constraint(s) is/are usually specified by the Customer?	
MSQ (1 mark)	(A)	Second Stage Climb Gradient
	(B)	Missed Approach Gradient
	(C)	Service Ceiling
	(D)	Cruise Mach Number
Solution: (C), (D)		

Q 2	Which of the following constraint(s) depend(s) on both Wing Loading and Thrust Loading?	
MSQ (1 mark)	(A)	Take-off distance
	(B)	Sustained Turn Rate
	(C)	Missed Approach Gradient
	(D)	Stalling speed
Solution: (A), (B)		

Q 3	Read the following statements and choose the correct option: I. There is only one unique approach to carry out Constraint analysis. II. Constraint analysis is carried out during preliminary design phase. III. Thrust Loading is constant through out the mission.	
MCQ (1 mark)	(A)	All the statements are correct.
	(B)	Only I is correct.
	(C)	Only II is correct.
	(D)	Only III is correct.
	(E)	Only I and II are correct.
	(F)	Only I and III are correct.
	(G)	Only II and III are correct.
	(H)	All the statements are incorrect.
Solution: (H)		

Q 4	Higher value of Thrust Loading results in_____.	
MSQ (1 mark)	(A)	Lower Rate of Climb
	(B)	Higher Cruise speed
	(C)	Higher fuel consumption
	(D)	Lower Sustained turn rate
Solution: (B), (C)		

Q 5	Estimate the typical value of Thrust Loading for a jet transport aircraft designed for a Maximum Mach Number of 0.8 in steady level flight. (Write your answer correct upto two decimal places)
NAT (1 mark)	Answer : 0.20 - 0.30

Solution:

$\frac{T}{W_0} = aM_{max}^{c}$

For a jet transport aircraft:

$a = 0.267$ and $c = 0.363$

$\frac{T}{W_0} = 0.267 * 0.8^{0.363}$

$\frac{T}{W_0} = 0.24$

Q 6	An aircraft is required to climb at an RoC of 10 m/s while flying at a forward speed of 150 m/s. Estimate the required Thrust to Weight ratio, if the Lift to Drag ratio during this shallow climb is 8. (Write your answer correct upto two decimal places)
NAT (1 mark)	Answer : 0.15- 0.25

Solution:

$\left(\frac{T}{W}\right)_{climb} = \frac{1}{\left(\frac{L}{D}\right)_{climb}} + \frac{V_{Vertical}}{V_{Forward}} = \frac{1}{8} + \frac{10}{150} = 0.125 + 0.067 = 0.192$

Q 7	Which of the following statement(s) is/are TRUE about Second Stage Climb Gradient (SSCG)?	
MCQ (1 mark)	(A)	Landing Gear is retracted but Flaps are in Take-off position.
	(B)	Landing Gear and Flaps are retracted.
	(C)	Landing Gear is extended and Flaps are in Take-off position.
	(D)	Landing Gear is extended and Flaps are retracted.
Solution: (A)		

Q 8	A four engined aircraft is approaching to Land with an L/D of 10. However, it is not allowed to Land due to poor visibility. Estimate the Thrust Loading required to meet the constraint on Missed Approach Gradient. (Write your answer correct upto three decimal places)
NAT (1 mark)	Answer : 0.167-0.175
Solution: $\left(\frac{T}{W}\right)_{MAG} = \frac{N}{N-1}\left\{\frac{1}{\left(\frac{L}{D}\right)_{Approach}} + \gamma_{MA}\right\} = \frac{4}{4-1}\left\{\frac{1}{10} + 0.027\right\} = 0.169$	

Q 9	Read the following statements and choose the correct option: I. Second Stage Climb Gradient puts an upper limit on Thrust Loading II. Missed Approach Gradient puts a lower limit on Thrust Loading III. L/D during Missed Approach is usually lower than L/D during Second Stage Climb.	
MCQ (1 mark)	(A)	All the statements are correct.
	(B)	Only I is correct.
	(C)	Only II is correct.
	(D)	Only III is correct.
	(E)	Only I and II are correct.
	(F)	Only I and III are correct.
	(G)	Only II and III are correct.
	(H)	All the statements are incorrect.
Solution: (G)		

Q 10	Which of the following statement(s) is/are TRUE about the constraint on Stalling Speed?	
MSQ (1 mark)	(A)	It puts a lower limit on Wing Loading.
	(B)	It directly affects both Wing Loading and Thrust Loading.
	(C)	It directly affects Wing Loading, and has no effect on Thrust Loading.
	(D)	It inversely affects Thrust Loading, and has no effect on Wing Loading
Solution: (C)		

Q 11	As per Raymer's approx. formula, the Landing Distance is directly proportional to_____.	
MSQ (1 mark)	(A)	Density Ratio
	(B)	Max. Lift Coefficient
	(C)	Wing Loading
	(D)	Thrust Loading
Solution: (C)		

Q 12	In a Constraint Diagram, the constraint on Stalling speed appears as:	
MCQ (1 mark)	(A)	an exponential curve between T/W and W/S.
	(B)	a parabolic curve between T/W and W/S.
	(C)	a straight line parallel to the T/W axis.
	(D)	a straight line parallel to the W/S axis.
Solution: (C)		

Q 13	In a Constraint Diagram, the constraint on Missed Approach Gradient appears as:	
MCQ (1 mark)	(A)	an exponential curve between T/W and W/S.
	(B)	a parabolic curve between T/W and W/S.
	(C)	a straight line parallel to the T/W axis.
	(D)	a straight line parallel to the W/S axis.
Solution: (D)		

Q 14	For a Transport Aircraft with certain specified Balanced Field Length, it is given during Take-off: Density Ratio = 1 Maximum Lift Coefficient = 2 Take-off Parameter = 500 kg/m^2 Which of the following can be possible combinations of W_o/S (in kg/m^2) and T_o/W_o (dimensionless).	
MSQ (1 mark)	(A)	200 and 0.2
	(B)	100 and 0.3
	(C)	300 and 0.1
	(D)	400 and 0.4
Solution: (A), (D)		

Q 15	In a Constraint Diagram, the constraint on Balanced Field Length appears as	
MCQ (1 mark)	(A)	an exponential curve between T/W and W/S.
	(B)	a parabolic curve between T/W and W/S.
	(C)	a straight line parallel to T/W axis.
	(D)	a straight line parallel to W/S axis.
	(E)	a line of the form $(T/W) = m(W/S) + C$, where $m \neq 0$ and $c = constant$
	(F)	a line of the form $(T/W) = m(W/S) + C$, where $m = 0$ and $c = constant$
Solution: (E)		