Quiz-2- Solutions.

Taking 1 Ton = 1000Kg

(1) T/o Mass = 175 Tons.
= 175×10^3 Kg

Take-of Speed = 85 m/s
Landing Speed = 70 m/s

(i) At take off

$9.8 \times 175 \times 10^3 = \frac{1}{2} \rho (A) V^2 \times C_L$

$\rho = 1.225$
$V = 85$ m/s

$$A = \frac{2 \times 1.75 \times 10^5 \times 9.81}{\rho \times C_L \times V^2}$$

$$A = \frac{2 \times 1.75 \times 10^5 \times 9.81}{1.225 \times 1.56 \times 85^2}$$

$A = 248.67 \text{ m}^2$ — Take off

ii) at landing

$$A = \frac{2 \times 1.474 \times 10^5 \times 9.81}{1.225 \times 1.56 \times 70^2}$$

175 - 27.6
= 147.4 Tons

$A = 308.84 \text{ m}^2$ Landing

Fixed wing Area = 308.84 m^2

① * 1 Ton = 907.2 kg | T/O Speed = 85 m/s
Landing Speed = 70 m/s

$$A_{T/O} = \frac{2 \times 175 \times 907.2 \times 9.81}{1.225 \times 1.56 \times 85^2}$$

$$A_{T/O} = 225.6 \text{ m}^2$$

$W_{Landing} = (175 - 27.6)$ Ton.
$= 147.4$ Tons

$$A_{Landing} = \frac{2 \times 147.4 \times 907.2 \times 9.81}{1.225 \times 1.56 \times 70^2}$$

$$A_{Landing} = 280.183 \text{ m}^2$$

Fixed Wing Area = 280.18 m^2

② at - begining of Cruise: 2% of Take-of weight is reduced.

$$W_{Cruise\,1} = 0.98 \times 175$$
$$= 171.5 \text{ Tons.}$$

at Start of descent = Landing mass + 0.2% W_{TO}

$$= 147.4 + 0.002 \times 175$$

$$W_{Cruise\,end} = 147.75 \text{ Tons.}$$

Temperature at 37000 feet.

$T_{37000} = T_{36080} = T_{11km}$ ⇒ Isothermal layer.

$T_{11km} = (273.15+15) - 11000 \times 0.0065$

$T_{11km} = 216.6\ K$

$V_{cruise} = 0.78 \times \sqrt{1.4 \times 287 \times 216.6}$

$$\boxed{V_{cruise} = 230.13\ m/s}$$

$$TSFC \times g_0 = 14.2\ \frac{gm}{KN\text{-}S} = \frac{14.2 \times 10^{-3}\ kg \times 9.81}{10^3\ N\text{-}S}$$

$$= 1.393 \times 10^{-4}\ \frac{N}{N\text{-}S}$$

$$\boxed{TSFC \times g_0 = 1.393 \times 10^{-4}\ \frac{N}{N\text{-}S}}$$

@ Constant Velocity and altitude.

$$R = \frac{V}{C} \times (LD) \times \ln\left(\frac{W_{01}}{W_{02}}\right)$$

$$R = \frac{230.13}{1.393 \times 10^{-4}} \times 21.6 \ln\left(\frac{171.5}{147.8}\right)$$

$$\boxed{R = 5307.07\ Kms.}$$

Answer- between 5250 kms TO 5350 kms

(3) at Steady Cruise.

$$\frac{T}{W} = \frac{D}{L} \Rightarrow$$

$$T = \frac{W \times D}{L} = \frac{171.5 \times 9.81 \times 907.2 kg}{21.6}$$

$$T = 70661.43\ N.$$

$$T_{TOC} = 1.2 \times 70661.43 = 84793.N$$

$$\frac{T_{TOC}}{W} = \frac{1}{4b} + \theta.$$

$$\theta = \frac{T_{TOC}}{W} - \frac{D}{L}$$

$$\theta = \frac{84793\ N}{171.5 \times 9.81 \times 907.2} - \frac{1}{21.6}$$

$$\theta = 9.27 \times 10^{-3} \text{ radians}$$
$$(or)$$
$$\theta = 0.53^{\circ}$$

$$\tan\theta = \frac{R_{OC}}{V_x} \Rightarrow R_{OC} = V_x \times \tan(0.53)$$

$$R_{OC} = 230 \times 9.25 \times 10^{-3}$$

$$R_{OC} = 2.13\ m/s$$

(4) at MSL $\rho = 1.225$ $A = 280\ m^2$

Constant altitude and attitude.

$$R = \frac{1}{TSFC\ g_0} \times \frac{C_L}{C_D} \times \sqrt{\frac{\rho}{9S}} \times \left(\sqrt{W_{fuel}} - \sqrt{W_{Final}} \right)$$

$$C_D = \frac{0.5}{21.6} = 0.0231$$

$$R = \frac{1}{1.398 \times 9.81} \times \frac{\sqrt{0.5}}{0.023} \times \sqrt{\frac{8}{1.225 \times 280}} \times \left(\sqrt{171 \times 9.81 \times 907.2} - \sqrt{147.8 \times 9.81 \times 907.2} \right)$$

$$R_{MSL} = 33585.2 \times 88.536$$

$$\boxed{R_{MSL} = 2973.5\ kms}$$

Answer between - 2900 kms - 3000 kms

$$R = \frac{1}{TSFC\ g_0} \frac{2 \times L}{D} (V_{fuel} - V_{Final})$$

This Formula is also Valid in part (4)