AE234 · Quiz 01 Soham S. Phanse 19D170030.

Q1 Thrust = 1061800 N = 1061.8 kN

takeoff mass = 540,000 kg.

$V_a = 110$ m/s. $\rho = 1.16$ kg/m^3 $S = 858$ m^2

$C_D = 0.02 + 0.042\, C_L^2$ fan diameter = 2.95 m

$f = 0.01$ $V_{core} = V_{bypass}$ (exhaust jets).

number of engines = 4.

~~we have Thrust =~~ ~~4x~~ Lift = Mg_0 = 540,000 kg × 9.81 m/s^2

$\therefore$ Lift = 5297400 N.

From drag polar equation we have $C_{D_0} = 0.02$.

$\therefore$ parasite drag $D_0 = C_{D_0} \cdot qS = C_{D_0} \cdot \frac{1}{2}\rho V_\infty^2 S$

$= \frac{1}{2} \times 0.02 \times 1.16 \times 110 \times 110 \times 858 = 120428.88$ N

$\boxed{D_0 = 120.428 \text{ kN}}$

$\therefore$ ~~Thrust = $\dot{m}(V_e - V_a)$~~

co-efficient of lift $C_L = \frac{L}{qS} = \frac{5297400}{\frac{1}{2}\rho V_\infty^2 \cdot S} = \boxed{0.879 = C_L}$

$\therefore$ substitute in drag polar.

$C_D = 0.02 + 0.042 \times (0.879)^2 = \boxed{0.0524 = C_D}$

$\therefore$ Drag = $C_D \times q \times S = C_D \times \frac{1}{2}\rho V_\infty^2 \times S = 315523.6656$ N.

$= \boxed{315.523 \text{ kN}}$

$\therefore \dot{m}_{fan}$ = Area of fan $\times \rho V_\infty$

$= \pi \times \frac{(2.95)^2}{4} \times \rho \times V_\infty = \boxed{872.136 \text{ kg/s}}$

$\therefore$ Thrust $= 4 \times \dot{m} \times \left(\left(1 + f\right) V_e - V_a\right)$

$= 4 \times 872.136 \left((1 + 0.01) V_e - V_a\right) = 1061800$

$\therefore V_e = \left[\frac{1061800}{4 \times 872.136} + V_a\right] \frac{1}{1.01} = 410.265$ m/s.

$\boxed{V_{exhaust} = 410.265 \text{ m/s}}$

~~η_p~~ Now, $r = \frac{V_a}{V_e} = \frac{110}{410.265} = 0.268119$

$\therefore \eta_p = \frac{2r}{1+r} = 0.4227 \doteq 42.27\ \%$

$\therefore \eta_{Th} = \frac{1-r^2}{E}$ $\quad E = \frac{2fQ_R}{V_e^2} = \frac{2\times 0.01\times 42\times 10^6}{(410.265)^2}$

$= 4.99$

$\therefore \eta_{Th} = \frac{1-(0.268)^2}{4.99} = 0.186$

$= 18.6\ \%$

$\therefore \eta_{overall} = \eta_{Th}\cdot\eta_p = 0.4227 \times 0.186 = 0.078$

$= 7.8\ \%$

→ at $T = 40°C = 313\ K$.

hence we get from standard atmospheric tables

$\rho =$ $\quad p =$

we should $\rho = 1.16\ kg/m^3$ $\quad \therefore p = \rho RT$

$p = 1.16 \times 287.1 \times 313 = 104240.268$ Pascals.

Because of temperature there will be change in density pressure, speed of sound. corresponding to it the mass flow rate through the engine fan. Then the thrust will get affected as it depends on mass flow rate. Because of this, exhaust velocity jet will change. Hence parameter E will change,

Hence η_{Th} & $\eta_{overall}$ will change

& η_p.

η_p due to V.exhaust changing

η_{Th} due to " & E

η_{ove} " " "