MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal)

V SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER MAKE UP EXAMINATIONS, FEBRUARY 2022

SUBJECT: AIRCRAFT DESIGN [AAE 3155]

REVISED CREDIT SYSTEM (19/02/2022)

Time: 75 mins

MAX. MARKS: 20

Instructions to Candidates:

- ✤ Answer ALL the questions.
- Missing data may be suitable assumed.
- Formula chart will be provided
- CO3 L4 Consider a subsonic turbofan passenger airplane with 150 passenger's capacity 1A (05) with 820km/hr cruising velocity at altitude of 11km with following datas:

Aspect ratio=12, S=85m², $\Lambda_{c/4}$ =45⁰, Safe range=4000km, Alternate airport is 400km away from destination. $TSFC_{cruise} = 0.62, TSFC_{loiter} = 0.56$

$$C_D = 0.02686 \cdot s^{-0.1} + \frac{1}{\pi A} \left(1 - 0.447 + \frac{0.2078}{Cos^2 \Lambda_c} \right) C_L^2$$

 $\frac{W_{warmup+taxiing+take-off}}{W_{take off weight}} = 0.97, \frac{W_{climb}}{W_{warmup+taxiing+takeoff}}$ W_{landing+taxiing} -=0.98,-

= 0.97

- i) Calculate fuel fraction for cruise (with a forward gust with 24m/s) and loiter
- ii) Calculate empty weight ratio ((const values A=1.02, c=-0.06)
- iii) Calculate take off weight (guess $W_0=75000$ kgf and number of crew=7), fuel weight and empty weight through iterative process.
- Consider a high subsonic jet airplane with an initial estimate of gross weight 1B (05) 78000kgf and wing loading of 6900N/m². Given parameters are: A=9, λ =0.32.

 $\Lambda_{c/4}=31^{\circ}$, t/c of airfoil=0.16, diameter of fuselage=4.1m, S_{HT}/S=0.3, S_{VT}/S=0.26, $S_{WET}/S=5.8$, speed of sound at 11km=295m/s, ρ at 11km=0.364, $M_{cr}=0.82$, H_{cr}=11km, R=3800km, TSFC=0.75, $(S_{wet})_w = 2 * S_{exposedwing} * (1 + 0.2(\frac{t}{c}))$

- Calculate C_{fe} and drag polar in terms of constants F₁, F₂ and F₃ (use drag i) polar equations from question)
- ii) Obtain wing loading under consideration of absolute ceiling
- iii) Obtain wing loading under consideration of balanced field length at take-off (BFL=0.2613TOP, $C_{L.max} = 2.8$, $\left(\frac{T}{W}\right)_{Take \ Off} = 0.32$) and consider $\pm 10\%$
- CO3 **2A** Write down methods and procedure to obtain the diameter of the propeller and (05) Calculate the diameter of propeller from the consideration of 40 seater twin turboprop airplane with following parameters: V_{cr} =450kmph, H_{cr} =4.5km, A=9,

AAE 3155

CO2 L3

L3

N=1300, wing loading=3100N/m², S=52m², assumed η =0.85, ρ at 4km=0.7768kg/m³,

$$C_D = 0.0335 \cdot s^{-0.1} + \frac{1.356}{\pi A} C_L^2$$

Choose appropriate values from the design chart :

Cs	β	J	η
2	30 ⁰	1.4	0.81
2.3	35 ⁰	1.6	0.84
2.5	40 ⁰	1.75	0.84

2B Describe the followings:

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a) landing run and landing distance

b) why we use turboprop engine when M<0.5

c) wide body fuselage

d) advantages of cranked wing

e) relieving weights on the wing

(05) ^{CO2} L2