Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VI SEMESTER B.TECH (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, JULY 2016

SUBJECT: AIRCRAFT DESIGN [AAE 304]

REVISED CREDIT SYSTEM

Time: 3 Hours Max Marks: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** the questions.
- Missing data may be suitable assumed.

1A) Write down the methods and procedure to obtain the diameter of the propeller and Calculate the diameter of propeller from the consideration of 40 seater turboprop airplane with following parameters: V_{cr}=540kmph, H_{cr}=4.5km, A=9.5, N=1500, wing loading=3400N/m^2, W_0=215000N, density at 4.5km = 0.7768kg/m^3, $C_D = 0.0335 \cdot s^{-0.1} + \frac{1.356}{\pi A} {C_L}^2$ **(05)**

C_S	β	J	η
1.5	25^0	0.95	0.82
2	30^0	1.4	0.81
2.5	40^0	1.75	0.84

1B) Explain the classification of aircraft wing(external and internal structures) consideration. also write down the advantages and disadvantages of canard configuration **(05)**

2A) Consider a twin turboprop passenger airplane carrying 40 passengers on board with cruise velocity of 400km/hr at altitude of 4km. Aspect ratio=10, S=56m^2, Safe range=800km, Alternate airport is 300km away from destination, consider 4 crews in airplane. $C_D = 0.03354 \cdot s^{-0.1} + \frac{1.356}{\pi A} {C_L}^2, \eta_{cruise} = 0.85, \eta_{loiter} = 0.75, BSFC_{cruise} = \frac{2.7N}{kw.hr}, BSFC_{loiter} = \frac{2.85N}{kw.hr}, \frac{W_{warmup+taxiing+take-off}}{W_{take\ off\ weight}} = 0.98, \frac{W_{climb}}{W_{warmup+taxiing+takeoff}} = 0.99, \frac{W_{landing+taxiing}}{W_{descent}} = 0.98,$ **(05)**

i) Calculate fuel fraction for cruise (consider forward gust with 18m/s) and loiter

ii) Calculate empty weight ratio(constant values A=0.92, c=-0.05)

iii) Calculate take off weight (guess W_0=15000kgf and number of crew=4), fuel weight and empty weight through iterative method

2B) Consider twin engine subsonic jet airplane with an initial estimate of gross weight 72000kgf and wing loading of 6300N/m^2. Given parameters are: A=11, λ=0.33. $\Lambda_{c/4}$=31^0, thickness of airfoil=0.16, diameter of fuselage=4.1m, S_{HT}/S=0.33, S_{VT}/S=0.25, S_{WET}/S=6, $(S_{wet})_{wing} = 2 * S_{exposedwing} * (1 + 0.2\left(\frac{t}{c}\right))$, **(05)**

$$C_D = 0.02686 \cdot s^{-0.1} + \frac{1}{\pi A}\left(1 - 0.447 + \frac{0.2078}{Cos^2\Lambda_{\frac{c}{4}}}\right){C_L}^2$$

i) Calculate drag polar in terms of constants F_1, F_2 and F_3
ii) Obtain wing loading under consideration of absolute ceiling and consider $\pm 5\%$

3A) Describe the followings: **(05)**

a) Operational requirements in aircraft design.
b) Different stages in aircraft designing
c) Wing loading and Thrust loading
d) Landing run and Landing distance
e) Turboshaft and turboprop engines

3B) Explain the different types of propellers which using in aviation industry and also write down their advantageous and disadvantageous. **(03)**

3C) What are empty weight and wheel tread in aviation? **(02)**

4A) Explain the effect of Aspect ratio on induced drag and structural weight. **(02)**

4B) Explain High-, mid- and low-wing configuration with their advantages and disadvantages. **(04)**

4C) Sketch the side view and plan view of a general aviation aircraft and indicate the important parts on them. **(04)**

5A) What are the features of the fuselage of a passenger airplane? **(02)**

5B) An aircraft has a wing area of S = 20 m^2, aspect ratio AR = 8, and taper ratio of 0.6. It is required that the 50 percent chord line sweep angle be 30 degrees. Determine tip chord, root chord, mean aerodynamic chord, span, and effective span. **(04)**

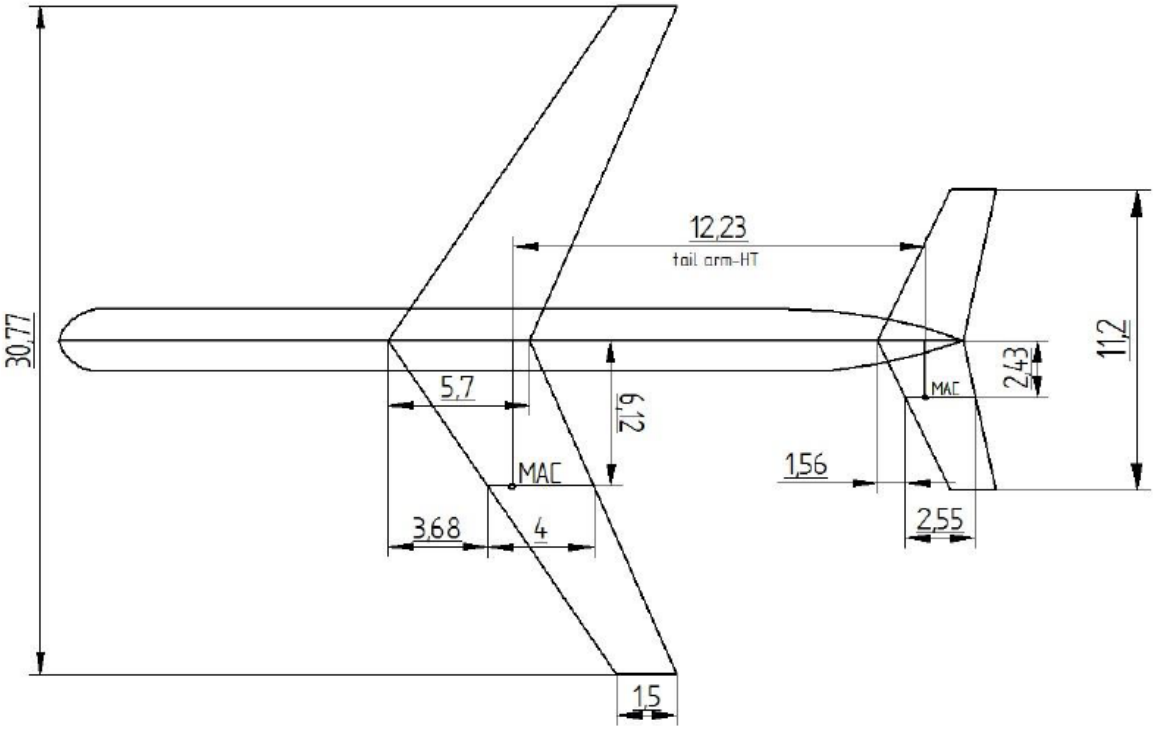
5C) Also determine the leading edge sweep, trailing edge sweep and quarter chord sweep angles. **(04)**

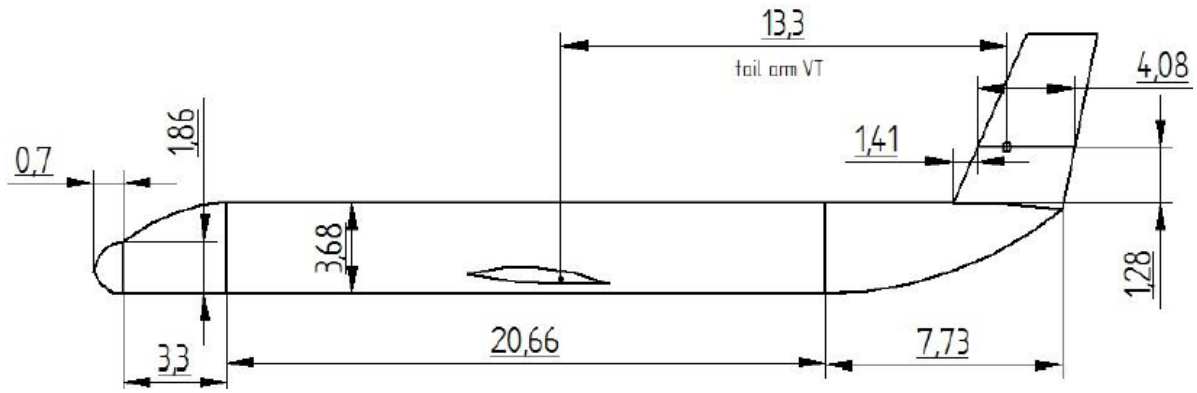
6A) An aircraft has a wing area of S = 20 m^2, aspect ratio AR = 8, and taper ratio of 0.6. It is required that the 50 percent chord line sweep angle be zero. Determine tip chord, root chord, mean aerodynamic chord, and span, as well as leading edge sweep, **(06)**

trailing edge sweep and quarter chord sweep angles.

6B) Consider a passenger twin bypass engines airplane with following parameters: **(04)**
S_{wing}=108.5m^2, S_{HT}=27.13m^2 (T-tail), S_{VT}=22.79m^2, W_0=38750kgf, W_{empty}/W_0=0.54, W_{fuel}/W_0=0.18, $W_{payload+crew}$=121520N, (From fig.1. all dimensions are in meters and all passengers are in fuselage mid-section).
Obtain the following. Weights and c.g. locations of (a) wing, (b) fuselage, (c) h.tail (d) v.tail (e) landing gear, (f) installed engine,
Weight of 1 engine=1500kgf, length of engine=2.95m, engine is 1.36m ahead of wing LE and C.G location of engine=41% of its length and engines are placed on the wing.
Landing gear(LG) wheel base=15.2m, W_{LG}/W_0=0.097

Fig.1.





Approximate weight buildup table:

Structures	Weight Factor	multiplier	≡C.G location
wing	49	$S_{exposed}$	40% of MAC
H.T & V.T	27	$S_{exposed}$	40% of MAC
Fuselage	24	S_{wetted}	45% of its length
Landing gear	0.097	W_0	
Installed Engine	1.3	Empty Weight	