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Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)



V SEMESTER B.TECH (AERONAUTICAL ENGINEERING) END SEMESTER EXAMINATIONS, DEC 2015/JAN 2016

SUBJECT: FLIGHT MECHANICS [AAE 301] REVISED CREDIT SYSTEM

Time: 3 Hours.

MAX.MARKS: 50

Instructions to Candidates:

- ✤ Answer ANY FIVE FULL questions.
- Missing data may be suitably assumed.
- **1A.** Using the average acceleration method, find the max power takeoff ground roll, **(06)** with no wind and a zero runway slope, for a 12,000*lb* T-38 at sea level and 6000 *ft* given the following conditions: $S = 170 ft^2$, $C_{L_{max}} = 0.88$, $\mu_r = 0.025$, $C_{D,0} = 0.02$, K = 0.2.
- **1B.** An aircraft has a 20kn headwind and would like a 200kn ground speed. If the **(04)** aircraft is flying at 10,000 ft (standard day), what indicated airspeed should it fly if the position error is -1 kn?
- **2A.** A turbojet airplane weighs 80,343.9 N, has a wing area of $37.2 m^2$ and has a **(06)** specific fuel consumption equal to 1.3 N/Nh at an altitude of 10,000 m ($\sigma = 0.374$). The airplane drag polar is given by $C_D = 0.02 + 0.06C_L^2$. Determine the fuel loads for
 - a) Range of 2400 Km.
 - b) Endurance of 5h.
 - c) With the fuel load in a) find the change in the range if the airplane encounters a steady headwind of 10m/s throughout the flight.
- 2B. Why the propulsive efficiency of a jet engine is less than that of a propeller even (04) though it produces enough thrust to propel the airplane to transonic and supersonic flight velocities?

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- **3A.** A piston-engine airplane has the following characteristics. W = 11,000 N, S = **(06)** $11.9 m^2, C_D = 0.032 + 0.055 C_L^2, C_{L_{max}} = 1.4$. Obtain the maximum and minimum speeds in level flight at an altitude of 3 km assuming that the engine *BHP* is 103 kW and the propeller efficiency is 83%.
- **3B.** How do the use of delta wings solve the problem of lift deficiency associated **(04)** with swept back wings?
- **4A.** An airplane weighing 180,000*N* has a wing area of 45 m^2 and drag polar given **(06)** by $C_D = 0.017 + 0.05 C_L^2$. Obtain the thrust required and power required for a rate of climb of 2,000 *m/min* at a speed of 540 *kmph* at 3 *km* altitude. ρ at 3 *km* altitude = 0.909 kg/m³.
- **4B.** Even though the resulting range is less than the maximum possible range, how **(04)** do we consider the more practical cruise speed for the propeller driven airplanes than the lower speed for maximum L/D?
- **5A.** Jane's all the Worlds Aircraft from 1993 lists data of the Fokker 50 Series 100: **(06)** wing span 29 m, wing area 70 m^2 , MTOW 19950 kg, max operating altitude 25000 ft, power plant: two Pratt & Whitney Canada *PW*125*B* turboprops, each flat rated at 1864 kW (2500 *SHP*) at Sea level. For cruise conditions, it can be assumed: maximum lift-to-drag ratio of 16, Oswald efficiency factor, e = 0.85, propeller efficiency, $\eta_P = 0.8$.
 - a) Calculate the aspect ratio A.
 - b) Calculate the drag coefficient at zero lift, $C_{D,0}$.
 - c) Calculate the aircraft's equivalent power, P_E at sea level conditions. Assume the ratio of jet thrust to propeller thrust to be 0.15.
 - d) Calculate the equivalent power at maximum operating altitude. Assume the variation of power with height is given by $P_E \propto \sigma^{0.5}$. σ is the relative density.
- **5B.** Find the true airspeed for max range and max endurance for an unpowered (04) *F*4 at 18,000 *ft* ($\rho = 0.00136$), *W* = 45000 *lb*, *C*_D = 0.027 + 0.209 *C*_L², *S* = 530 *ft*².
- **6A.** A propeller aircraft weighs 50,000 N and has a wing area of $30 m^2$. Its (06) reciprocating engine produces a thrust of 840 KW and the propulsive efficiency is 0.85. The airplane drag polar is given by $C_D = 0.025 + 0.05C_L^2$ and $C_{L_{max}} = 1.60, SFC = 3.0 N/KWh$. For the fuel load of 10000 N determine the best range and best endurance if the aircraft flies at an altitude of 3000 m ($\sigma = 0.7423$).

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6B. We assume in our performance analysis, there are no prevailing winds in the **(04)** atmosphere. Does wind has any effect on Range and Endurance of the airplane?