Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal)

IV SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, APRIL 2018

SUBJECT: AIRCRAFT PROPULSION [AAE 2202]

REVISED CREDIT SYSTEM (23/04/2018)

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.
- (Thermodynamics Data Handbook will be provided)
- 1A. A gas flows in a duct of 40 cm diameter at inlet pressure of 3 bar, temperature of 450 04 K and a velocity of 180 m/s. Calculate at inlet, a) Mass flow rate, b) Stagnation temperature, c) Mach Number, d) Stagnation pressure values assuming the flow as compressible and incompressible

(Take γ =1.3 and c_p=1.05 kJ/KgK)

- 1B. How is the analysis of compressible fluid different from that of an incompressible 02 fluid? Describe with suitable examples
- 1C. Explain with a neat figure the effect of back pressure on a converging nozzle 04
- 2A. Derive the equation for the speed of sound by using the conservation laws of mass 05 and momentum with an appropriate example.
- **2B.** Derive an expression for nozzle equation from fundamentals. Explain how this **05** expression is useful in determining the nozzle shape
- 3A. Explain any four forces acting on a propeller blade and show how it affects its 04 stability
- **3B.** Explain the 'feathering' operation in propeller? When it is normally carried out? **02**
- 3C. An aircraft flies at a speed of 610 kmph. The ambient conditions of air at the flight altitude are T=253K and P=0.55 bar. The diameter of the propeller of an aircraft is 3.7m and flight to jet speed ratio is 0.82. Use the given information to evaluate: (i)Thrust produced (ii) Specific thrust (iii) Thrust power (iv) Propulsive efficiency (v) Specific Impulse

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4A. Show that the exit jet from a Turbojet engine can be given as
$$c_e = \sqrt{2\eta_N c_p T_{04} \left[1 - \left(\frac{p_e}{p_{04}}\right)^{\frac{\gamma-1}{\gamma}}\right]}$$

4B. A turbojet engine operates at an altitude of 10.3 km and at a speed of 900kmph. The **06** engine has the following data:

Stagnation temperature at the turbine inlet = 1500 K;

Temperature drop in the turbine = 205 °C; Calorific value of fuel =42MJ/kg;

Turbine efficiency =0.92; Compressor efficiency =0.76;

Combustion chamber efficiency =0.95; Exhaust nozzle efficiency = 0.93

- Assume the properties of the combustion gases same as those of air and no stagnation pressure loss in the inlet diffuser. Stagnation pressure at the turbine entry = 0.97 x stagnation pressure at the compressor exit.
- Calculate: (i) Flight Mach number (ii) Air fuel ratio (ii) Compressor stagnation pressure ratio (iv) Turbine stagnation pressure ratio (v) Exhaust nozzle pressure ratio (vi) The velocity of the exhaust jet (vii) is the nozzle chocked?
- 5A Why propulsive efficiency of turbofan is greater than turbojet engine? What is bypass 02 ratio and its significance?
- **5B.** A ramjet engine propels an aircraft at a Mach 3.0 and at an altitude of 6160m. The diameter of the inlet diffuser at entry is 40cm and the calorific value of fuel is 43MJ/kg. The stagnation temperature at the nozzle entry is 1450K. The properties of the combustion gases are same as those of air (γ =1.4, R=287 J/kg K).

Determine: (a) Efficiency of ideal cycle, (b) Flight speed, (c) Airflow rate, (d) fuel – air ratio, (e) nozzle pressure ratio (f) nozzle jet Mach no. (g) Propulsive efficiency (h) Thrust

Assume: Diffuser efficiency =0.92; Combustion efficiency =0.97;

Nozzle jet efficiency = 0.95;

Stagnation pressure loss in the combustion chamber=0.02 P₀₂

5C. What are the advantages and disadvantages of a pulsejet engine when compared to a simple turbojet engine?