Hall Ticket No | | | | | | | | | | | Question Paper Code: AAEB08

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

B.Tech IV Semester End Examinations (Regular/Supplementary) - July, 2021

Regulation: R18

AEROSPACE PROPULSION

Time: 3 Hours **(AE)** **Max Marks: 70**

Answer FIVE Questions choosing ONE question from each module
(NOTE: Provision is given to answer TWO questions from any ONE module)
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

MODULE – I

1. (a) Classify the different types of air breathing engine based on specific thrust and propulsive efficiency. **[7M]**

   (b) A turbojet inducts 50 kg/s of air and propels an aircraft at a flight speed of 900km/hr. The isentropic enthalpy change for the nozzle is 200 kJ/kg and velocity coefficient is 0.94. The fuel air ratio is 0.012. The calorific value of fuel is 45 MJ/kg. Calculate i) Thermal efficiency ii) Thrust power iii) Propulsive efficiency iv) Overall efficiency **[7M]**

2. (a) Illustrate the ramjet and scramjet engines and highlight their differences based on principle of operation. **[7M]**

   (b) Develop the equation for propulsive efficiency and explain the reason for turbo fan having better propulsive efficiency. **[7M]**

MODULE – II

3. (a) Explain the various design variables for the inlet and nacelle and draw the neat sketch of typical streamline pattern for subsonic inlet. **[7M]**

   (b) An aircraft flies at a Mach number of 0.75 ingesting an airflow of 80 kg/s at an altitude where the ambient temperature and pressure are 222 K and 10 kPa, respectively. The inlet design is such that the Mach number at the entry to the inlet is 0.60 and that at the compressor face is 0.40. The inlet has an isentropic efficiency of 0.95. Find
   i) The area of the inlet entry ii) The inlet pressure recovery iii) The compressor face diameter. **[7M]**

4. (a) Explain in short about the combustion efficiency and main burner design parameters. **[7M]**

   (b) Determine the combustion efficiency of a main burner with the following data. Main burner inlet pressure = 13.78 bar, Main burner inlet temperature = 555.55K, Main burner inlet airflow = 45.35Kg/sec, Cooling effectiveness = 0.6, Main burner reference area = 1.5 ft^2, Height of main burner = 2 inch **[7M]**

MODULE – III

5. (a) Write down the basic function of exhaust nozzle and discuss the potential application of convergent and convergent divergent nozzle with suitable example. **[7M]**

   (b) Write short notes on following with neat sketch. i) Thrust vectoring ii) Over expanded nozzle iii) Under expanded nozzle **[7M]**

6. (a) Discuss the complete design procedure for selection of nozzle for a supersonic aircraft. **[7M]**

   (b) The idling turbojet engines of a landing airplane produce forward thrust when operating in a normal manner, but they can produce reverse thrust if the jet is property deflected. Suppose that, while the aircraft rolls down the runway at 100 mph, the idling engine consumes air at 100 lbm/s and produces an exhaust velocity of 450 ft/s.
   i) What is the forward thrust of the engine? ii) What is the magnitude and direction (forward or reverse) if the exhaust is deflected 90°and if the mass flow is kept constant? **[7M]**

MODULE – IV

7. (a) Discuss the effect of blade outlet angle, pre whirl and slip on the performance of axial flow compressor through velocity triangle. **[7M]**

   (b) A centrifugal compressor has an impeller tip speed of 366 m/s. Determine the absolute Mach number of the flow leaving the radial vanes of the impeller when the radial component of velocity at impeller exit is 30.5 m/s and the slip factor is 0.90. Given that the flow area at impeller exit is 0.1 m^2 and the total-to-total efficiency of the impeller is 90 %. Determine the mass flow rate. **[7M]**

8. (a) What are the advantages of centrifugal flow compressor over the axial flow compressor? Justify with appropriate reasoning. **[7M]**

   (b) Determine the factors affecting stage pressure ratio in a compressor. Is it important to stage for pressuring ratio? **[7M]**

MODULE – V

9. (a) Explain the different types of the losses in the axial flow turbine. **[7M]**

   (b) Analyze the single stage axial turbine has a mean radius of 30 cm and a blade height at the stator inlet of 6 cm. The gases enter the turbine stage at 1900 kPa and 1200 K and the absolute velocity leaving the stator is 600 m/s and inclined at an angle of 65 deg to the axial direction. The relative angles at the inlet and outlet of the rotor are 25 deg and 60 deg respectively. If the stage efficiency is 0.88, calculate i) the rotor rotational speed, ii) stage pressure ratio iii) flow coefficient iv) degree of reaction. **[7M]**

10. (a) What is the need for turbine blade cooling? Explain about the various types of cooling methods available for turbine blade. **[7M]**

    (b) b) A simple gas turbine takes in air at 1.0 bar and 27 °C and compresses to a pressure of 6 bar with the isentropic efficiency of compression being 85%. The air passes to the combustion chamber, and after combustion the gases enter the turbine a temperature of 560 °C and expand to 1.00 bar, the turbo efficiency being 80%. Neglecting the change of mass flow rate due to fuel, calculate the flow of air in kg per second for a net output of 1500 kW making the following assumptions: Loss of pressure in combustion chamber = 0.08 bar. **[7M]**

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