Hall Ticket No | | | | | | | | | | |  Question Paper Code: AAEC07

# INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal-500043, Hyderabad

**B.Tech IV SEMESTER END EXAMINATIONS (REGULAR/SUPPLEMENTARY) - AUGUST 2023**
**Regulation: UG-20**
**AIRCRAFT PROPULSION**

**Time: 3 Hours** **(AERONAUTICAL ENGINEERING)** **Max Marks: 70**

**Answer ALL questions in Module I and II**
**Answer ONE out of two questions in Modules III, IV and V**
**All Questions Carry Equal Marks**
**All parts of the question must be answered in one place only**

## MODULE – I

1. (a) Differentiate between turbojet, turbo prop and turbo fan engines and explain the advantages and disadvantages in detail. [BL: Understand| CO: 1|Marks: 7]

   (b) A turbojet engine is powering a fighter airplane. Its cruise altitude and Mach number are 10 km and 0.8, respectively. The exhaust gases leave the nozzle at a speed of 570 m/s and a pressure of 0.67 bar. The exhaust nozzle is characterized by the ratio $A_e/\dot{m}_a = 0.006m^2 \cdot$ s/kg. The fuel-to-air ratio is 0.02. It is required to calculate The specific thrust $(T/\dot{m}_a)$. The propulsive efficiency using ideal and actual equation. [BL: Apply| CO: 1|Marks: 7]

## MODULE – II

2. (a) Describe the process of combustion and distribution of flow through the combustors. [BL: Understand| CO: 2|Marks: 7]

   (b) Elucidate the modes of inlet operation in supersonic inlets. With a suitable sketch explain how the shock waves are playing a crucial role.? [BL: Understand| CO: 2|Marks: 7]

## MODULE – III

3. (a) Explain about the theory of flow through convergent divergent nozzle and state the condition for generating supersonic flow. [BL: Understand| CO: 3|Marks: 7]

   (b) An aircraft which is flying at an altitude of 10,000m, is powered by a turbojet engine. where Ta = 218K and Pa = 25kPa. The flight Mach number is found to be 0.92. The inlet conditions to the nozzle were found to be 1010 K and 58kPa. The specific heat ratio of air and gases are 1.4 and 1.33. The nozzle efficiency is 0.98. Find the thrust per inlet frontal area for C-D nozzle. [BL: Apply| CO: 3|Marks: 7]

4. (a) Demonstrate the methods of thrust reversal used in propeller and jet engine aircraft's with suitable sketch. [BL: Understand| CO: 4|Marks: 7]

   (b) Obtain a relation for Area-velocity relation with help of continuity equation and explain how a passage can act as nozzle as well as diffuser . [BL: Apply| CO: 4|Marks: 7]

## MODULE – IV

5. (a) With a neat diagram explain the principle and operation of centrifugal compressor and illustrate a labeled diagram of a compressor. [BL: Understand| CO: 5|Marks: 7]

   (b) A centrifugal compressor has to deliver 35 kg of air per sec. The impeller is 76 cm diameter revolving at 11,500 rpm with an adiabatic efficiency of 80%. If the pressure ratio is 4.2:1, estimate the probable axial width of the impeller at the impeller tip if the radial velocity is 120 m/s. The inlet conditions are 1 bar and $47^0C$. [BL: Apply| CO: 5|Marks: 7]

6. (a) Determine the equation for work done and pressure rise across axial flow compressor. [BL: Understand| CO: 5|Marks: 7]

   (b) An axial flow air compressor of 50% reaction design has blades with inlet and outlet angles of 45 deg and 10 deg respectively. The compressor is to produce a pressure ratio of 6:1 with an overall isentropic efficiency of 0.85 when inlet static temperature is $37^0C$. The blade speed and axial velocity are constant throughout the compressor. Assuming a value of 200 m/s for blade speed, find the number of stages required if the work done factor is unity . [BL: Apply| CO: 5|Marks: 7]

## MODULE – V

7. (a) Interpret the flow through the axial flow turbine and draw velocity triangles. [BL: Understand| CO: 6|Marks: 7]

   (b) Gas at 7 bar and $300^0$ expands to 3 bar in an impulse turbine stage.The nozzle angle is $70^0$ with reference to the exit direction. The rotor blades have equal inlet and outlet angles, and the stage operates with the optimum blade speed ratio. Assuming that the isentropic efficiency of the nozzles is 0.9, and that the velocity at entry to the stage is negligible, deduce the blade angle used and the mass flow required for this stage to produce 75 kW. Take Cp = 1.15 kJ/kg K. [BL: Apply| CO: 6|Marks: 7]

8. (a) Describe the turbine blade cooling techniques adopted for gas turbine engines. [BL: Understand| CO: 6|Marks: 7]

   (b) In a single-stage impulse turbine the nozzle discharges the fluid on to the blades at an angle of $65^0$ to the axial direction and the fluid leaves the blades with an absolute velocity of 300 m/s at an angle of $30^0$ to the axial direction. If the blades have equal inlet and outlet angles and there is no axial thrust, estimate the blade angle, power produced per kg/s of the fluid and the blade efficiency. [BL: Apply| CO: 6|Marks: 7]

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