Hall Ticket No | | | | | | | | | | |  Question Paper Code: AMEC20

# INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal-500043, Hyderabad

**B.Tech V SEMESTER END EXAMINATIONS (REGULAR/ SUPPLEMENTARY) - FEBRUARY 2024**
**Regulation: UG20**
**THERMAL ENGINEERING**
**(MECHANICAL ENGINEERING)**

**Time: 3 Hours** **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) Describe in detail about the efficiency, types, and applications of Rankine cycle. [BL: Understand| CO: 1|Marks: 7]

   (b) A utility runs a Rankine cycle with a water boiler at 3.5 MPa and the cycle has the highest and lowest temperatures of 450°C and 45°C respectively. Find the plant efficiency and the efficiency of a Carnot cycle with the same temperatures. [BL: Apply| CO: 1|Marks: 7]

## MODULE – II

2. (a) Classify various types of nozzles. Express in detail about the effects of friction on the flow through a steam nozzle. [BL: Understand| CO: 2|Marks: 7]

   (b) Dry saturated steam at a pressure of 8 bar enters a convergent- divergent nozzle and leaves at a pressure of 1.5 bar. If the flow is adiabatic and frictionless, determine:

   i) The exit velocity of steam.

   ii) Ratio of cross section at exit and that at throat.

   Assume the index of adiabatic expansion to be 1.135. [BL: Apply| CO: 2|Marks: 7]

## MODULE – III

3. (a) Outline with a neat sketch the velocity compounding, pressure compounding and pressure-velocity compounding. [BL: Understand| CO: 3|Marks: 7]

   (b) In a D-level turbine, the steam enters the wheel through a nozzle with a velocity of 500 m/s and at an angle of 20° to the direction of motion of the blade. The blade speed is 200 m/s and the exit angle of the moving blade is 25°. Find the inlet angle of the moving blade, exit velocity of steam and its direction and work done per kg of steam? [BL: Apply| CO: 3|Marks: 7]

4. (a) Explain in detail about the classifications of condensers. List its advantages and disadvantages. [BL: Understand| CO: 4|Marks: 7]

   (b) An air water vapor mixture enters an air conditioning unit at pressure of 1.0 bar 38°C DBT, and a relative humidity of 75%. The mass of dry air entering is 1Kg/s. The air-vapour mixture leaves the air conditioning unit at 1 bar, 18°C, 85% relative humidity. The moisture condensed leaves at $18^0$. Determine the heat transfer rate for the process. [BL: Apply| CO: 4|Marks: 7]

## MODULE – IV

5. (a) Compare closed and semi-closed cycles in gas turbine plant. State the merits and demerits of open cycle gas turbine. [BL: Understand| CO: 5|Marks: 7]

   (b) The air enters the compressor of an open cycle constant pressure gas turbine at a pressure of 1 bar and temperature of 20°C. The pressure of the air after compression is 4 bar. The isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The air-fuel ratio used is 90:1. If flow rate of air is 3 kg/s. Find

   i) Power developed

   ii) Thermal efficiency of the cycle. [BL: Apply| CO: 5|Marks: 7].

6. (a) Describe in detail about the parameters that affect the performances of the gas turbine. [BL: Understand| CO: 5|Marks: 7]

   (b) A gas turbine consists of a two-stage compressor with perfect intercooler and a single stage turbine. If the plant works between the temperature limits of 300K and 1000K and 1 bar and 16 bar respectively. Find the net power of the plant per kg of air. Take specific heat at constant pressure as 1 KJ/Kg K. [BL: Apply| CO: 5|Marks: 7]

## MODULE – V

7. (a) Demonstrate with the neat sketches the principle of operation of the following:
   i) Turbofan engine

   ii) Turbojet engine. [BL: Understand| CO: 6|Marks: 7]

   (b) An aircraft propeller flies at a speed of 440kmph. The diameter of the propeller is 4.1m and the speed ratio is 0.8. The ambient conditions of air at the flight altitude are T=255K and P=0.55bar. Find the thrust, thrust power and propulsive efficiency. [BL: Apply| CO: 6|Marks: 7]

8. (a) Illustrate the working principles of a Turbo-pump feed system with a schematic diagram for liquid propellant rocket engines. [BL: Understand| CO: 6|Marks: 7]

   (b) In the rocket engine, propellant flow rate is 5.2 kg/s, nozzle exit diameter is 9 cm, nozzle exit pressure is 1.02 bar, ambient pressure is 1.013 bar, thrust chamber pressure is 22 bar and thrust is 7.2 kN. Calculate the following :

   i) Effective jet velocity

   ii) Actual jet velocity

   iii) Specific impulse

   iv) Specific propellant consumption [BL: Apply| CO: 6|Marks: 7]

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