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

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
(Dundigal-500043, Hyderabad)

B.Tech V SEMESTER END EXAMINATIONS (REGULAR) - DECEMBER 2022
Regulation:UG20
THERMAL ENGINEERING

Time: 3 Hours **(MECHANICAL 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) What do you understand by mean temperature of heat addition? Explain its influence on efficiency of Rankine cycle. [BL: Understand| CO: 1|Marks: 7]

   (b) A cyclic steam power plant is to be designed for a steam temperature at turbine inlet of 360°C and an exhaust pressure of 0.08 bar. After isentropic expansion of steam in the turbine, the moisture content at the turbine exhaust is not to exceed 15 %. Determine the greatest allowable steam pressure at the turbine inlet, and calculate the Rankine cycle efficiency for these steam conditions. [BL: Apply| CO: 1|Marks: 7]

MODULE – II

2. (a) Describe the function of a steam separator and briefly explain the working principle of a baffle plate steam separator. [BL: Understand| CO: 2|Marks: 7]

   (b) Dry saturated steam at a pressure of 11 bar enters a convergent-divergent nozzle and leaves at apressure of 2 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) List the sources of air leakage in to the condensers? Summarize the reasons for inefficiency in surface condensers. [BL: Understand| CO: 3|Marks: 7]

   (b) In a reaction turbine, the blade tips are inclined at 35° and 20° in the direction of motion. The guideblades are of the same shape as the moving blades, but reversed in direction. At a certain place in the turbine,the drum diameter is 1 metre and the blades are 10 cm high. At this place, the steam has a pressure of 1.75 bar and dryness 0.935. If the speed of this turbine is 250 r.p.m and the steam passes through the blades without shock, find the mass of steam flow and power developed in the ring of moving blades. [BL: Apply| CO: 3|Marks: 7]

4. (a) Write about compounding of turbine. Outline the concept of pressure and velocity compounding. with neat diagram. [BL: Understand| CO: 4|Marks: 7]

(b) A surface condenser deals with 136.25 kg of steam per hour at a pressure of 0.09 bar. The steam enters 0.85 dry and the temperature at the condensate and air extraction pipes is 36°C. The air leakage amounts to 7.26 kg/hour. Determine i) The surface required if the average heat transmission rate is 3.97 kJ/cm^2 per second ii) The cylinder diameter for the dry air pump, if it is to be single-acting at 60 r.p.m. with a stroke to bore ratio of 1.25 and volumetric efficiency of 0.85.

[BL: Apply| CO: 4|Marks: 7]

MODULE – IV

5. (a) Describe with neat sketch, the working of a simple constant pressure 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 3.0 kg/s, find i) Power developed ii) Thermal efficiency of the cycle. Assume cp = 1.0 kJ/kg K and $\gamma = 1.4$ for air and gases. Calorific value of fuel = 41800 kJ/kg.

[BL: Apply| CO: 5|Marks: 7]

6. (a) Illustrate with block diagram the closed cycle gas turbine plant and also represent the processes on T-S diagram with intercooler, heat exchanger and reheating processes.

[BL: Understand| CO: 5|Marks: 7]

(b) A large stationary Brayton cycle gas-turbine power plant delivers a power outputof 100 MW to an electric generator. The minimum temperature in the cycle is 300K, and the maximum temperature is 1600 K. The minimum pressure in the cycle is 100 kPa, and the compressor pressure ratio is 14 to 1. Calculate the power output of the turbine. What fraction of the turbine output is required to drive the compressor? What is the thermal efficiency of the cycle? [BL: Apply| CO: 5|Marks: 7]

MODULE – V

7. (a) Illustrate with the help of entropy and enthalpy diagrams a turbo jet gas turbine plant. How it is differs from turbo prop plant? [BL: Understand| CO: 6|Marks: 7]

(b) The diameter of the propeller of an aircraft is 2.5 m. It flies at a speed of 500 km/hr at an altitude of 8000 m (density of air 0.525 kg/m^3) with flight to jet speed ratio of 0.75. Determine i) The air flow rate through the propeller ii) Thrust produced iii) Specific thrust.

[BL: Apply| CO: 6|Marks: 7]

8. (a) Mention the requirements of an ideal rocket propellant and applications of rockets. Compare solid and liquid propellant rockets. [BL: Understand| CO: 6|Marks: 7]

(b) A turbojet engine operates at an altitude where the ambient temperature and pressure are 216.7 K and 24.444 kPa, respectively. The flight Mach number is 0.9 and the inlet conditions to the convergent nozzle are 1000 K and 60 kPa. If the nozzle efficiency is 0.98, the ratio of specific heat is 1.33, determine whether the nozzle is operating under choked conditionor not. Determine the nozzle exit pressure. [BL: Apply| CO: 6|Marks: 7]

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