Hall Ticket No | | | | | | | | | | Question Paper Code: AME003

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Four Year B.Tech III Semester End Examinations (Regular) - November, 2018

Regulation: IARE – R16

THERMODYNAMICS

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

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

UNIT – I

1. (a) Define a thermodynamic system and explain how systems are classified? You have been asked to do metabolism (energy) analysis of a human being. How would you define the system for this purpose? What type of system is this? **[7M]**

   (b) A fluid contained in a cylinder receives 150 kJ of mechanical energy by means of a paddle wheel, together with 50 kJ in the form of heat. At the same time, a piston in the cylinder moves in such a way that the pressure remains constant at 200 kN/m^2 during the fluid expansion from $2m^3$ to $5m^3$. What is the change in internal energy, and in enthalpy. **[7M]**

2. (a) Derive the equation of steady flow energy equation in terms of time and mass. Apply the SFEE to derive the work done from a turbine. **[7M]**

   (b) A Turbine operates under steady flow conditions, receiving steam at the following state: pressure 1.2 MPa, temperature 188^0C, enthalpy 2785 kJ/kg, velocity 33.3 m/s and elevation 3m. The steam leaves the turbine at the following state: pressure 20 kPa, enthalpy 2512 kJ/kg, velocity 100 m/s, and elevation 0 m. Heat is lost to the surroundings at the rate of 0.29 kJ/s. If the rate of steam flow through the turbine is 0.42 kg/s, what is the power output of the turbine in kW? **[7M]**

UNIT – II

3. (a) (i)State Kelvin-Planck statement of Second Law of Thermodynamics **[7M]**

   (ii) An inventor claims that his engine has the following specifications:

   Temperature limits ...... 27^0C and 627^0C

   Power developed ...... 50 kW

   Fuel burned per hour ...... 3 kg

   Heating value of the fuel ...... 75000 kJ/kg

   State whether his claim is valid or not.

   (b) A heat pump is run by a reversible heat engine operating between reservoirs at 800^0C and 50^0C. The heat pump working on Carnot cycle picks up 15 kW heat from reservoir at 10°C and delivers it to a reservoir at 50^0C. The reversible engine also runs a machine that needs 25 kW. Determine the heat received from highest temperature reservoir and heat rejected to reservoir at 50^0C. **[7M]**

4. (a) Derive Helmholtz and Gibbs Functions for non-flow reversible system? **[7M]**

   (b) A single stage air turbine is to operate with air inlet pressure and temperature of 1 bar and 600 K. During the expansion, the turbine losses are 20 kJ/kg to the surroundings which is at 1 bar and 300 K. For 1 kg of mass flow rate determine **[7M]**

   (i) Decrease in availability

   (ii) Maximum work

   (iii) The Irreversibility.

UNIT – III

5. (a) A pressure cooker contains 2 kg of steam at 5 bar and 0.9 dry calculate the quantity of heat which must be rejected so as to the quality of the steam becomes 0.5 dry? **[7M]**

   (b) Write short note on Mollier chart and its construction. Show the throttling and isentropic expansion on Mollier chart. **[7M]**

6. (a) Define universal gas constant and characteristic gas constant. Show that for an ideal gas, c_p-c_v=R **[7M]**

   (b) A reversible adiabatic process begins at $p_1 = 10$ bar, $t_1 = 300^{\circ}$C and ends with p_2=1 bar. Find the specific volume and work done per kg of fluid if (i) The fluid is air (ii) The fluid is steam **[7M]**

UNIT – IV

7. (a) State and explain Dalton's law of Partial pressures and derive the equation of characteristic constant for a gas mixture **[7M]**

   (b) Two vessels A and B, both containing nitrogen are connected by a valve which is opened to allow the contents to mix to achieve an equilibrium temperature of 27°C. Before mixing the following information is known about the gases in the two vessels. **[7M]**

Vessel A	Vessel B
P=1.5 MPa	P=0.6 MPa
T=50°C	T=20°C
Contents = 0.5 kg mol	Contents = 2.5 kg

8. (a) What is psychrometry. Describe briefly the following processes with psychrometric chart representation **[7M]**

   (i) Cooling and dehumidification

   (ii) Heating and humidification

   (b) Atmospheric air with dry bulb temperature of 28^0 C and wet bulb temperature of 17^0 C is cooled to 15^0 C without changing its moisture content Find (i) Original relative humidity,(ii) Final relative humidity, (iii) Final wet bulb temperature and (iv) change in enthalpy. Use psychrometry chart. **[7M]**

UNIT – V

9. (a) Air enters the compressor of a gas turbine plant operating on Brayton cycle at 101.325 kPa, 27^0C. The pressure ratio in the cycle is 6. Calculate the maximum temperature in the cycle and the cycle efficiency. Assume WT= 2.5 times WC, where WT and WC are the turbine and the compressor work respectively. Take $\gamma = 1.4$. **[7M]**

   (b) A refrigerator working on Bell-Colemon cycle operates between pressure limits of 1.05 bar and 8.5 bar.Air is drawn from the cold chamber at 10^0 C compressed and then it is cooled to 30^0 C before entering the expansion cylinder. The expansion and compression follows the law $pv^{1.3}$ =C.Determine the theoretical COP of the system. **[7M]**

10. (a) Draw the p-v and t-s diagrams of an Otto cycle and derive its air standard efficiency. **[7M]**

    (b) An engine working on Otto cycle has an air standard efficiency of 56% and rejects 544 kJ/kg of air. The pressure and temperature of air at the beginning of compression are 0.1Mpa and 60°C respectively. Compute **[7M]**

    (i) the compression ratio of the engine

    (ii) the work done per kg of air

    (iii) the pressure and temperature at the end of compression

    (iv) the maximum pressure in the cycle

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