Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV(NEW) – EXAMINATION – SUMMER 2019

Subject Code:2143406 Date:09/05/2019

Subject Name: Thermo Dynamics and Thermal Engineering

Time:02:30 PM TO 05:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Show that internal energy is Property of the system. **03**

(b) Write and explain the First Law of Thermodynamics. **04**

(c) A fluid system, contained in a piston and cylinder machine, passes through a complete cycle of four processes. The sum of all heat transferred during a cycle is – 340 kJ. The system completes 200 cycles per min. **07**

Complete the following table showing the method for each item, and compute the net rate of work output in kW.

Process	Q(KJ/min)	W(KJ/min)	dU(KJ/min)
1-2	0	4340	------
2-3	42000	0	-------
3-4	-4200	----------	-73200
4-1	----------	----------	---------

Q.2 **(a)** Write a short note on Brayton cycle. **03**

(b) Write a short note on modified Rankine cycle, **04**

(c) Explain Rankine cycle with p-v and T – s diagram and find the efficiency of Rankine cycle. **07**

OR

(c) The power developed by a turbine in a certain steam plant is 1200 kW. The heat supplied to the steam in the boiler is 3360 kJ/kg, the heat rejected by the system to cooling water in the condenser is 2520 kJ/kg and the feed pump work required to pump the condensate back into the boiler is 6 kW. **07**

Q.3 **(a)** Define Effectiveness. **03**

(b) One kg of air is compressed polytropically from 1 bar pressure and a temperature of 300 K to a pressure of 6.8 bar and temperature of 370 K. Determine the irreversibility if the sink temperature is 293 K. Assume R = 0.287 kJ/kg K, cp = 1.004 kJ/kg K and cv = 0.716 kJ/kg K. **04**

(c) Derive and Explain Clausius-Claperyon Equation with p-T Diagram **07**

OR

Q.3 **(a)** Define and explain Available and Unavailable Energy **03**

(b) 15 kg of water is heated in an insulated tank by a churning process from 300 K to 340 K. If the surrounding temperature is 300 K, find the loss in availability for the process. **04**

(c) Derive Maxwell's equation **07**

Q.4 **(a)** State and explain Dalton's law **03**

(b) A vessel of 0.35 m3 capacity contains 0.4 kg of carbon monoxide (molecular weight = 28) and 1 kg of air at 20°C. Calculate : **04**

(i) The partial pressure of each constituent

(ii) The total pressure in the vessel, and

The gravimetric analysis of air is to be taken as 23.3% oxygen (molecular weight = 32) and 76.7% nitrogen (molecular weight = 28).

(c) Prove the following relation $M = \frac{\sum n_i M_i}{\sum n_i} \frac{1}{\sum \frac{m_{fi}}{M_i}}$ **07**

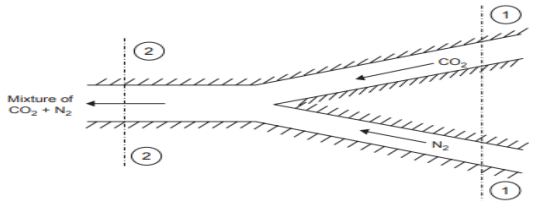
where,
M = Molecular weight of the mixture,
n_i = Number of moles of an any constituent,
m_{fi} = Mass fraction of the constituent, and
M_i = Molecular weight of the constituent.

OR

Q.4 **(a)** Show that $C_v = \frac{R}{\gamma - 1}$ **03**

(b) Write a short note on Compressibility chart **04**

(c) 4 kg of carbon dioxide at 40°C and 1.4 bar are mixed with 8 kg of nitrogen at 160°C and 1.0 bar to form a mixture at a final pressure of 0.7 bar. The process occurs adiabatically in a steady flow apparatus. Calculate : **07**
(i) The final temperature of the mixture ; (ii) The change in entropy.
Take value of C_p : for CO_2 = 0.85 kJ/kg K and N_2 = 1.04 kJ/kg K.



Q.5 **(a)** A hot plate 1 m × 1.5 m is maintained at 300°C. Air at 25°C blows over the plate. If the convective heat transfer coefficient is 20 W/m^2°C, calculate the rate of heat transfer. **03**

(b) Write a short note on Thermal Conductivity **04**

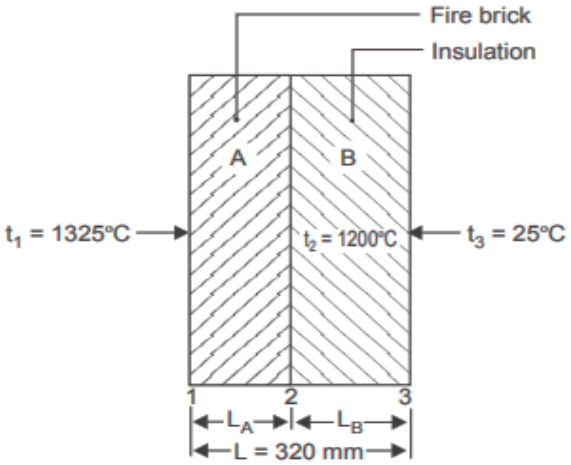
(c) The effective temperature of a body having an area of 0.12 m^2 is 527°C. Calculate the following : (i) The total rate of energy emission. (ii) The intensity of normal radiation, and (iii) The wavelength of maximum monochromatic emissive power. Take;$\sigma = = 5.67 \times 10^{-8} \frac{W}{m^2K^4}$ **07**

OR

Q.5 **(a)** Define black body, white body & gray body. **03**

(b) The inner surface of a plane brick wall is at 60°C and the outer surface is at 35°C. Calculate the rate of heat transfer per m^2 of surface area of the wall, which is 220 mm thick. The thermal conductivity of the brick is 0.51 W/m°C. **04**

(c) A reactor's wall 320 mm thick, is made up of an inner layer of fire brick (k = 0.84 W/m°C) covered with a layer of insulation (k = 0.16 W/m°C). The reactor operates at a temperature of 1325°C and the ambient temperature is 25°C. (i) Determine the thickness of fire brick and insulation, which gives minimum heat loss. (ii) Calculate the heat loss presuming that the insulating material has a maximum temperature of 1200°C. **07**
If the calculated heat loss is not acceptable, then state whether addition of another layer of insulation would provide a satisfactory solution.



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