Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER I (OLD) – • EXAMINATION – SUMMER 2016

Subject Code: 712101N Date:16/05/2016

Subject Name: Applied Thermodynamics & Heat Transfer

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)** Explain : Perpetual motion machine of first and second kind. Define Kelvin-Planck and Clausius statement. Show the equivalence of Kelvin-Planck and Clausius statement. **07**

(b) State and explain the physical significance of the following : **07**

(i) Nusset number (ii) Reynold's number and (iii) Pecklet number

Q.2 **(a)** Write Vander-Waal's equation. Show that its critical parameters are given by $V_c = 3b$, $P_c = a/27b^2$ and $T_c = 8a/27Rb$. Also give the defects of VanderWaal's equation. **07**

(b) Explain the concept of exergy and entropy. **07**

OR

(b) Derive Maxwell's equations. **07**

Q.3 **(a)** Explain the concept of phase rule and phase equilibrium for multi component system. **07**

(b) Prove that in case of fin insulated at tip, temperature distribution along the length of the fin is given by **07**

$$\frac{\theta}{\theta 0} = \frac{\cosh m(l - x)}{\cosh ml}$$

OR

Q.3 **(a)** Derive Clausius- Clapeyron equation. **07**

(b) Explain the analytical method for solving two dimensional steady state heat conduction problems. **07**

Q.4 **(a)** Explain hydrodynamic boundary layer, boundary layer thickness and thermal boundary layer with neat sketches. **07**

(b) State and explain any two laws of radiation. **07**

OR

Q.4 **(a)** In a quenching process, a copper plate 3 mm thick is heated upto 400 °C and then exposed to an ambient temperature at 25°C, with the convective coefficient of 28 W/m^2K. Calculate the time required for the plate to reach the temperature of 50°C. Take thermo physical properties as **07**

$C = 380$ J/kg K, $\rho = 8800$ kg/m^3, $K = 385$ W/m-K

(b) Two large parallel plates at temperature 1000 K and 600 K have emissivity of 0.5 and 0.8 respectively. A radiation shield having emissivity 0.1 on one side and 0.05 on the other side is placed between the plates. Calculate the heat transfer rate by radiation per square metre and without radiation shield. **07**

Q.5 **(a)** Derive necessary Von-Karman's expression for convective heat transfer. **07**

(b) Explain Reynold's analogy for turbulent flow over a flat plate. **07**

OR

Q.5 **(a)** Explain the following terms in relation with radiation heat transfer : **07**

(i) Solid angle, (ii) Radiosity and (iii) Radiation intensity

(b) A thin plate of length 2 m and width of 1.5 m is exposed to a flow of air parallel to its surface along 2 m side. The velocity and temperature of the free stream flow of air are 3 m/sec and 20°C respectively. The plate surface temperature is 90°C. Determine the lengthwise mean local heat transfer coefficient at the end of the plate and amount of heat transferred. Take the following properties of air at 20°C : **07**

$\nu = 15.06 \times 10^{-6}$ m^2/sec, $K = 2.59 \times 10^{-2}$ W/m-°C, $Pr = 0.703$.

Use the relation:

$$Nu = 0.664 (Re)^{1/2} (Pr)^{1/3}$$

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