Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**ME - SEMESTER– I (OLD course)• EXAMINATION – SUMMER 2015**

**Subject Code: 712101 Date: 11/05/2015**

**Subject Name: Applied Thermodynamics and Heat Transfer**

**Time: 10:30 am to 1:00 pm Total Marks: 70**

**Instructions:**

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

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|---|---|---|---|
| **Q.1** | **(a)** | State Kelvin-Planck and Clausius statement and prove that violation of Kelvin-Planck statement leads to violation of Clausius statement. | **07** |
| | **(b)** | Derive a relation for radiation exchange between black bodies separated by a non-absorbing medium and obtain the relation for reciprocity theorem, $A_1F_{1-2} = A_2 F_{2-1}$ | **07** |
| **Q.2** | **(a)** | What is Joule-Thompson coefficient ? Discuss the zone of heating and cooling with the help of inversion curve. | **07** |
| | **(b)** | Explain the concept of phase rule and phase equilibrium for multi component system. | **07** |
| | | **OR** | |
| | **(b)** | Discuss briefly Helmholtz and Gibbs function. | **07** |
| **Q.3** | **(a)** | Derive Maxwellôs relations. | **07** |
| | **(b)** | What is meant by irreversibility ? How do you distinguish between irreversibility and unavailable energy ? | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | Explain Stefan-Boltzmannôs law and Lambertôs cosine law of radiation. | **07** |
| | **(b)** | In a straight tube of 60 mm diameter, water is flowing at a velocity of 12 m/sec. The tube surface temperature is maintained at 70 °C and flowing water is heated from the inlet temperature 15 °C to an outlet temperature of 45°C. Calculate the following :<br>(i) The heat transfer coefficient from the tube surface to the water<br>(ii) Heat transferred, and<br>(iii) Length of the tube<br>The physical properties of water at its mean bulk temperature, 30 °C are :<br>$\rho$ = 995.7 kg/m$^3$, $C_p$ = 4.174 kJ/kg °C, K = 61.718 x 10$^{-2}$ W/m °C,<br>$\nu$ = 0.805 x 10$^{-6}$ m$^2$/sec, Pr = 5.42<br>Use the relation,<br>Nu = 0.023 (Re)$^{0.8}$ (Pr)$^{0.333}$ | **07** |
| **Q.4** | **(a)** | Explain the physical significance of following dimensionless numbers:<br>(i) Reynoldôs number<br>(ii) Stanton number<br>(iii) Grashoff number | **07** |
| | **(b)** | Derive Von-Karmanôs expression for convective heat transfer. | **07** |
| | | **OR** | |
| **Q.4** | **(a)** | Derive an expression for heat dissipation through a rectangular fin when the end of the fin is insulated. | **07** |

**(b)** A steel rod (K =32 W/m°C), 12 mm in diameter and 60 mm long, with an insulated end, is to be used as a spine. It is exposed to surroundings with a temperature of 60 °C and a heat transfer coefficient of 55 $W/m^2$ °C. The temperature at the base of fin is 95 °C. Determine : **07**

(i) Fin efficiency
(ii) Temperature at the edge of the spine
(iii) Heat dissipation

**Q.5** **(a)** Explain briefly graphical method for solving two-dimensional steady state heat conduction problem. **07**

**(b)** A steel ball 50 mm in diameter and at 900 °C is placed in still atmosphere of 30°C. Calculate the initial rate of cooling of the ball in°C/min. Take : **07**
$\rho$ = 7800 $kg/m^3$, C = 2 kJ/kg °C (for steel), h = 30 $W/m^2$ °C .
Neglect internal thermal resistance.

**OR**

**Q.5** **(a)** Write a note on Reynoldôs analogy. **07**

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

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