Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME SEMESTER – I (OLD) EXAMINATION – SUMMER 2017

Subject Code: 711101N Date:08/05/2017

Subject Name: Advanced Thermodynamics and Heat Transfer

Time:02:30 P.M. to 05:00 P.M. 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)**	Derive the one- dimensional, steady state heat conduction equation with internal heat generation in Cartesian coordinate system.	**07**
	(b)	Define critical radius of insulation? Deduce the expression for it. Explain it concept with help of material and surface resistances.	**07**
Q.2	**(a)**	Define Following: (i) Critical Reynolds Number (ii) Prandtl Number (iii) Grashof Number (iv) Nusselt Number (v) Stanton Number (vi) Peclet Number (vii) Graetz Number.	**07**
	(b)	Derive expressions for temperature distribution and heat dissipation in a straight fin of rectangular profile.	**07**
		OR	
	(b)	Two ends of a fin of cross sectional area 200 mm^2 and length 1m are maintained at 127 ºC and 227 ºC. Perimeter is 20 mm. it loses heat from the surface due to natural convection to the surrounding at 27 ºC with a surface heat transfer coefficient of 5 W/m^2 ºC. Find the minimum temperature in the fin and its location. Thermal conductivity of fin material is 45 W/mºC	**07**
Q.3	**(a)**	What are Fourier and Biot numbers? What is the physical significance of these numbers?	**07**
	(b)	Write a brief note on Kirchhoff's law of radiation.	**07**
		OR	
Q.3	**(a)**	Show by dimensional analysis that for forced convection, $Nu = \phi(\mathrm{Re}, \mathrm{Pr})$.	**07**
	(b)	Derive an energy equation for the thermal boundary layer over a flat plate.	**07**
Q.4	**(a)**	Write a short note on Wien's displacement law	**07**
	(b)	Discuss about the radiation shape factors and radiation shield. With its applications.	**07**
		OR	
Q.4	**(a)**	Explain the second law of thermodynamic statements given by (i) Clausius statement (ii) Kelvin – Planck statement. Prove that they are equivalent.	**07**
	(b)	Derive Clapeyron equation $\frac{dp}{dT} = \frac{h_{fg}}{T\left(v_g - v_f\right)}$ by Using Maxwell's relation $\left(\frac{\partial p}{\partial T}\right)_v = \left(\frac{\partial s}{\partial v}\right)_T$	**07**

Q.5 **(a)** Discuss the available energy referred to an infinite thermal reservoir and a finite thermal reservoir. **07**

(b) Derive the three *T.ds* equations as stated below: **07**

$$(i)\ Tds = C_v dT + T\left(\frac{\partial p}{\partial T}\right)_v dv\ ;\ (ii)\ Tds = C_p dT - T\left(\frac{\partial v}{\partial T}\right)_p dp$$

OR

Q.5 **(a)** Establish inequality of Clausius **07**

(b) Show that the enthalpy of a fluid before throttling is equal to that after throttling. **07**

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