Seat No.: _____ **Enrolment No._____**

GUJARAT TECHNOLOGICAL UNIVERSITY

ME Semester –I Examination Feb. - 2012

Subject code: 711101N **Date: 11/02/2012**
Subject Name: Advanced Thermodynamics and Heat Transfer
Time: 10.30 am – 01.00 pm **Total Marks: 70**

Instructions:

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

Q.1 **(a)** Establish the general differential equation in Cartesian co-ordinates for 3-D unsteady heat conduction by considering an infinitesimal volume element. Deduce there from the conduction equations for the following cases. **07**

(i) Steady state 2-D flow with heat generation at uniform rate within material.
(ii) Steady 1-D flow with heat generation.

(b) What is critical thickness of insulation on a small diameter wire or pipe, Explain its physical significance and derive an expression for the same **07**

Q.2 **(a)** Under what circumstances from the heat transfer point of view, will the use of finned walls be better? And Explain the significance of fin effectiveness and fin efficiency **07**

(b) Define Reynolds, Nusselt ,Prandtl and Stantion numbers, Explain their importance in convective heat transfer **07**

OR

(b) A horizontal pipe 305 mm in diameter is maintained at a temperature of 250ºC in a room where the ambient air is at 20ºC. Calculate the free convection heat loss per meter length of the pipe per hour. **07**

Take the following properties at mean temperature of (250+20)/2= 135ºC
k = 0.034 W/m-K, ν = 26.25 x 10^{-6} m^2/s, Pr = 0.68

Q.3 **(a)** State Kelvin-Plank and Clausius statements of the second law of thermodynamics and prove that they are equivalent. **07**

(b) Using the four perfect differentials **07**

$$du = Tds - pdv; dh = Tds + vdp; dg = vdp - sdT; and\ df = -pdv - sdT$$

Derive the following Maxwell's relations for systems

$$(i)\left(\frac{\partial T}{\partial v}\right)_s = -\left(\frac{\partial p}{\partial s}\right)_v ;\quad (ii)\left(\frac{\partial p}{\partial T}\right)_v = \left(\frac{\partial s}{\partial v}\right)_p$$

OR

Q.3 **(a)** Describe Joule's experiment. What does it signify? Derive Joule-Thomson coefficient.

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

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

$$and\ Tds = C_v\left(\frac{\partial T}{\partial p}\right)_v dp + C_p\left(\frac{\partial T}{\partial v}\right)_p dv$$

Q.4 **(a)** What are Heisler Charts? Explain their significance in solving transient conduction problems. **07**

(b) Define Grashof number. Explain its significance in natural convection heat transfer **07**

OR

Q.4	**(a)**	Derive the expression for change in entropy during isothermal process, constant volume process and constant pressure processes.	**07**
	(b)	What are the criteria of thermodynamic equilibrium? What are different types of equilibriums? Discuss in detail.	**07**
Q.5	**(a)**	State and explain Wien's displacement law and define Lambert's cosine law of radiation.	**07**
	(b)	Derive an expression for the shape factor in case of radiation exchange between two surfaces.	**07**

OR

Q.5	**(a)**	Describe the Carnot cycle and prove that efficiency of all reversible engines working between the same two temperatures depends only on the temperatures of the hot and cold reservoirs and is independent of the working substance.	**07**
	(b)	An engineer claims his engine to develop 3.4 kW. The engine consumes 0.44 kg of fuel of calorific value of 41,870 kJ/kg in one hour. The maximum and minimum temperatures recorded in the cycle are 1400 ºC and 350 ºC respectively. Whether the engineer is justified in his claim?	**07**

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