Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – I • EXAMINATION – SUMMER • 2014

Subject code: 711101N **Date: 13-06-2014**

Subject Name: Advanced Thermodynamics and Heat Transfer

Time: 02:30 pm - 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)** Prove that the 3-dimensional conduction equation in cylindrical co-ordinate for a homogeneous material, steady state condition and without heat generation. **07**

(b) Give and explain the following statements of second law of thermodynamic (i) Clausius statement (ii) Kelvin ï Planck statement. Prove that they are equivalent. **07**

Q.2 **(a)** For a plane wall with uniform heat generation having different temperature on both surfaces (T1 at x = 0 and T2 at x = L, where, L is a thickness of wall). Derive the expression for temperature distribution and heat flow from both the surfaces. **07**

(b) Derive the expressions for temperature distribution through Piston crown and thickness of it. **07**

OR

(b) Derive the equation for heat dissipation by a fin with an insulated tip $Q = \sqrt{hPkA}\left(T_0 - T_\infty\right)\tanh\left(mL\right)$, by integrating the convective losses along its surfaces. **07**

Q.3 **(a)** Derive an expression for the shape factor in case of radiation exchange between two surfaces. **07**

(b) State and explain Stefan Boltzmann law. Derive an expression for total emissive power of a blackbody. **07**

OR

Q.3 **(a)** State and explain Wienôs displacement law and define Lambertôs cosine law of radiation. **07**

(b) What is Reynolds analogy? Describe the relation between fluid friction and heat transfer. **07**

Q.4 **(a)** Define the compressibility factor and describe its utility for computing gas state. Explain how compressibility charts for real gases are prepared and state the utility of such charts. **07**

(b) Using Maxwellôs relation $\left(\frac{\partial p}{\partial T}\right)_v = \left(\frac{\partial s}{\partial v}\right)_T$ derive Clapeyron equation $\frac{dp}{dT} = \frac{h_{fg}}{T\left(v_g - v_f\right)}$ And explain the utility of this equation in thermodynamics. **07**

OR

Q.4 **(a)** Using the four perfect differentials **07**

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

Derive the following Maxwellâs relations for systems

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

(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.5 **(a)** Differentiate clearly between the following: **07**

(i) Macroscopic and microscopic views,

(ii) Diathermal wall and adiabatic wall.

(b) Explain calculation of available energy referred to (i) an infinite thermal reservoir and (ii) a finite thermal reservoir. **07**

OR

Q.5 **(a)** What are energy equations? State these in case of the following: **07**

(i) Non- flow process,

(ii) Steady continuous flow and

(iii) Heating of fluid without change of phase.

(b) What do you understand by entropy transfer? Why is entropy transfer associated with heat transfer and not with work transfer? **07**

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