

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular/ Backlog), April-May 2016

B. Tech in Mechanical Engineering, Semester IV

Roll No.....

ME 408: Heat Transfer

Time: 3 hours

Max. Marks: 100

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.
4. You are allowed to use the correlation sheet (signed by faculty) during exam. Anything else written on the correlation sheet (even a slightest mark) will lead to a case of unfair means.

Q.1 Objective type multiple choice questions (10 questions @ 1 mark)

10

- i. The temperature drop in a heat generating solid under steady state conditions depends to a greater extent on
 - (a) Linear dimension
 - (b) Thermal conductivity
 - (c) Heat generation rate
 - (d) Convection coefficient at the surface
- ii. The thermal gradient in a heat generating cylinder under steady state conditions at half the radius location will be
 - (a) One half of that at the surface
 - (b) One fourth of that at the surface
 - (c) Twice that at surface
 - (d) Four times that at surface
- iii. The temperature gradient in the fluid flowing over a flat plate
 - (a) will be zero at the surface
 - (b) will be positive at the surface
 - (c) will be very steep at the surface
 - (d) Will be zero at top of B.L.
- iv. In flow over a flat plate the convection coefficient
 - (a) always increases along the flow
 - (b) Decreases, increases and decreases
 - (c) Increases upto critical Reynolds no and then decreases
 - (d) Decreases upto critical Reynolds no and then increases
- v. In nucleate pool boiling the heat flux depends on
 - (a) only the material of the surface
 - (b) material and roughness of the surface
 - (c) independent of surface quality
 - (d) Fluid material and surface roughness
- vi. With increase in excess temperature the heat flux in boiling
 - (a) increases continuously
 - (b) decreases and then increases
 - (c) Increases, decreases and again increases
 - (d) Decreases, increases & again decreases
- vii. The overall heat transfer coefficient is the
 - (a) sum of all resistances
 - (b) Sum of all conductances
 - (c) Sum of the convection coefficients
 - (d) Resistance due to wall material
- viii. The flow direction is immaterial in the case of heat exchange from



- (a) Wet or saturated steam to water
 (b) Water to gas (c) Oil to water (d) Oil to gas
- ix. A gray surface is one for which
 (a) $\rho = \varepsilon$ (b) $\varepsilon = \tau$ (c) $\varepsilon = \text{constant}$ (d) $\alpha = \rho$
- x. The reciprocity theorem states (fill in the blank)
- Q.2 Short answer type questions (4 questions @ 2.5 marks) 10
- Give the explanation of your answer given for question no. 1(viii).
 - Define shape factor. Under what conditions the shape factor of a surface with another surface will be (a) zero (b) unity.
 - Discuss the conditions that will necessitate the use of fins.
 - Explain critical radius of insulation.
- Q.3A Explain various modes of heat transfer and the mechanism behind them. 05
- Q.3B What is boundary condition? Explain various types of boundary condition. 05
- Q.4A Engine oil at 60°C flows over the upper surface of 5m long flat plate whose temperature is 20°C with a velocity of 2 m/s. Determine the total rate of heat transfer per unit width of entire plate. Also write the assumptions made. 05
- Q.4B A vertical plate measuring 180mmx180mm and at 50°C is exposed to atmosphere at 10°C. Find the convective heat transfer from this surface. Also find the maximum velocity that would occur in the B.L. 05
- Q.5A The temperature of a black surface, 0.5 m² in area, is 727°C. Find (i) the total rate of energy emission (ii) the intensity of normal radiation (iii) the intensity of radiation at an angle of $\pi/3$ & (iv) the wavelength of maximum monochromatic emissive power. 05
- Q.5B Two black planes are maintained at 127°C and 227°C, respectively. They are lying parallel opposite to each other. By what factor, the net heat exchange increases if the temperature difference is doubled by increasing the temperature of the hotter plane from 227°C to 327°C. 05
- Q.6A Determine the area required in a parallel flow heat exchanger to cool oil from 60°C to 30°C using water available at 20°C. The outlet temperature of the water is 26°C. The rate of flow of oil is 10 kg/sec. the specific heat of the oil is 2200 J/kg-K. The overall heat transfer coefficient is 300W/m²-K. Compare the area required for a counter flow exchanger. 05
- Q.6B A heat exchanger is to heat water from 20°C to 80°C at a rate of 1.2 kg/sec. the heating is to be done by geothermal water (C_p = 4.34 kJ/kg-K) available at 160°C at a flow rate of 2 kg/sec. Find the effectiveness of heat exchanger. 05
- OR
- Q.6B Explain the concept of NTU for heat exchanger design. 05
- Q.7A Two slabs are placed in contact, but due to roughness only 40% of the surface area is in contact and the gap in the remaining area is 0.02 mm thick and is filled with air. The slabs are 10 cm thick each and their conductivities are 15.5 W/m-K and 200 W/m-K. The temperature of the hot surface is at 250°C and the outside

surface of the other slab is at 35°C . Determine the heat flow and the contact resistance. The conductivity of air is 0.0321 W/m-K .

Q.7B Derive the expression for fin effectiveness. Write the meaning of symbols used with units. 05

OR

Q.7B A long horizontal tube of 2.5 cm OD is immersed in hot oil bath at 100°C . The tube surface is at 20°C . Determine the value of convection coefficient. 05

Q.8A Discuss the regimes of pool boiling in detail. Draw neat sketches and label each axis and point on the curve. 10

Q.9A Obtain the general heat conduction equation in 3-D Cartesian system with heat generation. Also obtain the Poisson's equation for the same. 10

Q.9B Obtain the expression for velocity and mass flow rate in film wise condensation problem on a vertical plate. 10

OR

Q.9B Obtain the expression for LMTD for a counter flow double pipe heat exchanger. 10

Best of Luck

