

KATHMANDU UNIVERSITY
End Semester Examination
March/April, 2017

Marks Scored:

Level : B.E.

Year : ~~II~~ III

Exam Roll No. :

Time : 30 mins.

Course : MEEG 306

Semester: I

F. M. : 20

Registration No. :

Date APR 09 2017

SECTION "A"

[20 Q. \times 1 = 20 marks]

Cross [x] mark the most appropriate answer.

1. Thermal conductivity of solid metals with rise in temperature normally _____
[] increases [] decreases [] remains constant [] is unpredictable
2. Heat transfer in a straight line, without affecting the intervening medium, is called _____
[] conduction [] convection [] radiation [] advection
3. Sensible heat is the heat required to _____
[] change vapor into liquid
[] change liquid into vapor
[] increase the temperature of liquid or vapor
[] convert saturated steam into dry steam
4. The insulation ability of an insulator with the presence of moisture would generally _____
[] increase [] decrease
[] remain unaffected [] may increase or decrease
5. Which of the following is a case of steady state heat transfer?
[] heating in building [] air preheaters
[] I.C. engine [] none of the above
6. A designer chooses the values of fluid flow rates and specific heats in such a manner that the heat capacities of the two fluids are equal. A hot fluid enters the counter flow heat exchanger at 100 °C and leaves at 60 °C. A cold fluid enters the heat exchanger at 40 °C. The mean temperature difference between the two fluids is _____
[] 20 °C [] 40 °C [] 60 °C [] 66.7 °C
7. Fin length that cause efficiency to drop below _____ percent usually cannot be justified economically.
[] 50 [] 60 [] 70 [] 80
8. Joule sec is the unit of _____
[] universal gas constant [] kinematic viscosity
[] thermal conductivity [] Planck's constant

9. Studies show that error involved in 1 D fin analysis is negligible when $h\delta/k$ is _____
 0 < 0.1 < 0.2 < 0.3
10. A furnace is made of a red brick wall of thickness 0.5 m and conductivity 0.7 W/mK. For the same heat loss and temperature drop, this can be replaced by a layer of diatomite earth of conductivity 0.14 W/mK and thickness _____
 0.05 m 0.1 m 0.2 m 0.5 m
11. For a spring system, with spring constant 30 N/m and initial and final displacement 9 m and 4 m respectively, the spring work is equal to _____
 150 J 750 J 975 J 1080 J
12. Heat is considered as a fluid like substance that is massless, colorless, odorless, tasteless and can be poured from one body into another according to _____ theory.
 Kinetic Joules Caloric Wiens
13. The heat transfer for adiabatic fin tip can be appropriately given by _____
 $Q = (hpkA_c)^{1/2}(T_b - T_\infty) \tanh mL$
 $Q = (hpkA_c)^2(T_b - T_\infty)$
 $Q = (hpkA_c)^{1/2}(T_b - T_\infty)$
 $Q = (hpkA_c)^{1/2}(T_b - T_\infty)(\sinh mL - \cosh mL)$
14. For vertical plates, the critical Grashof number is _____
 10^3 10^6 10^9 10^{12}
15. Which of this is not dimension less quantity?
 capacity ratio UA
 effectiveness of NTU NTU
16. Effectiveness of a fin is not a direct function of _____
 thermal conductivity surface or cross-sectional area
 temperature difference convective heat transfer coefficient
17. The area density for a compact heat exchanger is at least _____
 $600 \text{ m}^2/\text{m}$ $600 \text{ m}^2/\text{m}^3$ $700 \text{ m}^2/\text{m}$ $700 \text{ m}^2/\text{m}^3$
18. The value of _____ constant is 6.626069×10^{-34} J.s.
 Boltzmann's Planck's Wien's Kirchoff's
19. The quantity that describes the magnitude of radiation emitted in a specified direction in space is _____
 solid angle radiosity radiation intensity emissivity
20. In a flow boiling system, a sharp decrease in the heat transfer coefficient is seen at _____
 bubbly flow slug flow annular flow mist flow

Level : B.E.
Year : III
Time : 2 hrs. 30 mins.

Course : MEEG 306
Semester: I
F.M. : 55

SECTION "B"

Attempt ALL questions. Formula sheet is attached with the question paper; any extra data sheet is not allowed. Assume suitable data if necessary.

Q.No.1

1. A homogeneous wall of area A and thickness δ has left and right hand surface temperatures of 0°C and 40°C respectively. Determine the temperature at the center of the wall.
 - a. How much material must be added and to which side of the wall if the temperature at the centre is to be raised by 5°C ?
 - b. How much material must be removed and from which side of the wall if the temperature at the center line of the wall is to be lowered by 5°C ?Express in terms of δ . Presume that surface temperature remain same before and after the change. [5]
2. A square plate heater of 0.8 kW rating and measuring 15 cm by 15 cm is placed between two slabs A and B and the following data refers to these slabs:
Slab A is 1.8 cm thick with $k = 55 \text{ W/m}^\circ\text{C}$.
Slab B is 1 cm thick with $k = 0.2 \text{ W/m}^\circ\text{C}$.
The outside heat transfer coefficients on the sides of plate A and B are $200 \text{ W/m}^2^\circ\text{C}$ and $45 \text{ W/m}^2^\circ\text{C}$ respectively. If the surrounding environment is at 27°C temperature, make calculations for the maximum temperature of the system and outside surface temperature of both slabs. [4]
3. Briefly explain the significance of critical thickness of insulation with illustrations. [2]

Q.No.2

1. Two rods A and B of the same length and diameter protrude from a surface at 120°C and are exposed to air at 25°C . The temperatures measured at the end of the rods are 50°C and 75°C . If the thermal conductivity of material A is $20 \text{ W/m}^\circ\text{C}$, calculate the thermal conductivity of material B. Adopt the condition of an insulated fin tip. [4]
2. A plate fin of 10 mm thickness and 80 mm length is dissipating heat from a surface at 190°C . The fin is exposed to air at 25°C with a convection coefficient of $22 \text{ W/m}^2^\circ\text{C}$. If thermal conductivity of the fin material is $200 \text{ W/m}^\circ\text{C}$, determine the heat dissipation. Consider 1m width of fin. To increase the heat dissipation, the following two alternatives have been suggested with the same material volume. (a) Split the fins of 5 mm thickness each (b) Single fin 5 mm thick and 160 mm long. Which will be the better choice? The fins may be considered short with insulated tip. [5]
3. Explain the significance of corrected length in extended surface heat transfer analysis. [2]

Q.No.3

1. Calculate the approximate Reynold's numbers and state if the flow is laminar or turbulent for the following:
 - a. A compressor disc of radius 0.3 m rotating at 15000 rpm in air at 5 bar and 400 °C and $\mu = \frac{1.46 \times 10^{-6} T^{3/2}}{110+T}$ kg/ms; T in kelvin. [2]
 - b. 0.05 kg/s of CO₂ gas at 400 K flowing at a 20 mm diameter pipe and $\mu = \frac{1.56 \times 10^{-6} T^{3/2}}{233+T}$ kg/ms; T in kelvin. [2]

2. The temperature profile at a particular location on the surface of plate is prescribed by the identities:
 - a. $\frac{t_s - t}{t_s - t_\infty} = \sin \frac{\pi y}{0.015}$
 - b. $\frac{t_s - t}{t_s - t_\infty} = \frac{1}{2} \left(\frac{y}{0.0075} \right)^3 + \frac{3}{2} \left(\frac{y}{0.0075} \right)$
 If thermal conductivity of air is stated to be 0.03 W/m°C, determine the value of convective heat transfer coefficient in each case. [4]

3. The crank case of an automobile is approximated as 0.6 m long, 0.2 m wide, and 0.1 m deep. Assuming that the surface temperature of the crank case is 350 K. Estimate the rate of heat flow from the crank case to atmosphere at 276 K at a road speed of 30 m/s. Assume that the vibration of the engine and chassis induce the transmission from laminar to turbulent flow very near to leading edge that for practical purposes the boundary layer is turbulent over the entire surface. Neglect the radiation and use for the front and rear surfaces, same heat transfer coefficient as for bottom and sides. [3]

Q.No.4

- 1) Calculate nucleate boiling heat transfer coefficient for water boiling on the tube, whose wall temperature is maintained at 20 °C, above saturation temperature. Assume water to be at 20 bar. Also, calculate the heat transfer coefficient when,
 - a. Temperature is reduced by 10 °C at 20 bar.
 - b. Pressure is reduced by 10 bar at 20 °C temperature difference.
 Comment on the result. Use correlation: $h_A = 5.56 (\Delta T)^3$ W/m²K and $h_p = h_A \{p/p_0\}^{0.4}$ W/m²K. 'A' corresponds to atmospheric pressure; 'p' corresponds to fluid pressure. Assume atmospheric pressure to be 100 kPa. [4]

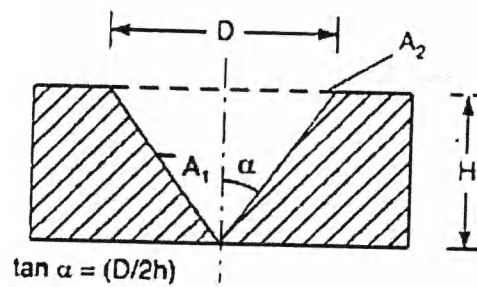
- 2) In a balanced counter flow heat exchanger, where $m_c C_{p,c} = m_h C_{p,h}$. Show that $\Delta T_1 = \Delta T_2 = \Delta T$, at any section, and the temperature profile of two fluids are parallel and linear. Also, prove that $\Delta T_{LMTD} = \Delta T_1 = \Delta T_2$. [3]

- 3) Derive the overall heat transfer coefficient for a wall system with inside and outside at different fluid exposure. Explain the effect of fouling in these kind of system. [4]

Q.No.5

1. Explain Gray Lambert Body Approximation or Wien's Displacement Law with proper figure and representative equations. [3]
2. Determine the value of Stefan Boltzmann's Constant using Max Planck's Distribution Law. [3]

3. Calculate the shape factor of a conical hole as shown in Figure. [2]



4. A spherical liquid oxygen tank 0.3 m in diameter is enclosed concentrically in a spherical container of 0.4 m diameter and the space in between is evacuated. The tank surface is at -183°C and has an emissivity of 0.2. The container surface is at 15°C and has an emissivity of 0.25. Determine the net radiant heat transfer rate and rate of evaporation of liquid oxygen if its latent heat is 220 kJ/kg. [3]

