Baba Banda Singh Bahadur Engineering College, Fatehagarh Sahib

Department of Mechanical Engineering

Question Bank

Practice Set. 1

Subject: HEAT TRANSFER   **Class: 6ᵗʰSemMech**

SECTION A

1. Differentiate between heat transfer and thermodynamics.

3. Differentiate between conduction & convection heat transfer.

5. What do you mean by overall heat transfer coefficient?

6. What do you mean by critical thickness of insulation?

7. Drive units for heat conductivity & heat transfer coefficient.

8. What is thermal diffusivity? Explain its significance.

9. Explain shape factor for heat transfer by conduction.

10. What is Fourier law of heat transfer by conduction?

11. Give examples of steady & unsteady heat flow.

13. What do you mean by variable thermal conductivity?

14. Explain electrical analogy of heat transfer by conduction.

15. Air is bad conductor of heat then how temp. of air rises in summers.

16. Explain factors effecting heat transfer coefficient.

SECTION-B

1) Consider a slab of thickness 0.25m. One surface is kept at $100^{\circ}C$ and the other surface at $0^{\circ}C$. Determine the net flux across the slab if the slab is made from pure copper. Take $K_{copper} = 387.6$ WmK.

[Ans: 1.55×10^5 W/m^2]

2) A furnace wall is composed of 220mm of fire brick, 150mm of common brick, 50mm of magnesia and 3mm of steel plate on the outside. If the inside surface temperature is $1500^{\circ}C$ and outside surface temperature is $90^{\circ}C$, estimate the temperatures between layers and calculate the heat loss in kj/h-m^2 , K(for fire brick) = 4 kj/m-h- $^{\circ}C$, K(for common brick) = 2.8kj/m-h-$^{\circ}C$, K(for magnesia) = 0.24kj/m-h-$^{\circ}C$, K(for steel)= 240kj/m-h-$^{\circ}C$.

[Ans: $1016^{\circ}C$, $1255^{\circ}C$, 4449 kj/m^2]

3) An exterior wall of a house may be approximated by a 0.1m layer of common brick (K = 0.7 W/mK) followed by a 0,04m layer of gypsum plaster (K = 0.48 W/mK). What thickness of loosely packed rock wool insulation (K = 0.065 W/mK) should be added to reduce the heat loss or gain through the wall by 80%.

[Ans: 58.8mm]

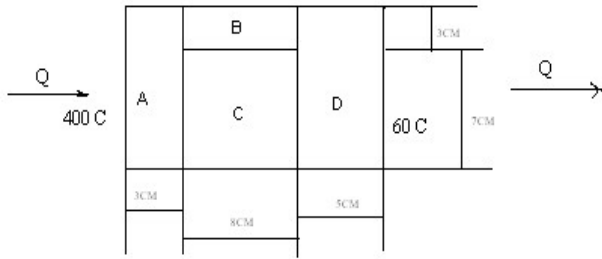4) Find the heat flow rate through the composite wall as shown in fig.

K_A= 150 WmK

K_B= 30 WmK

K_C= 65 WmK

K_D=50 WmK

Width of wall perpendicular to paper=10cm

5) A mild steel tank of wall thickness 12mm contains water at 95°C. The thermal conductivity of mild steel is 50W/mK and the heat transfer coeff for the inside and outside the tank are 2850 and 10W/m$^{2\circ}$C respectively. If the atmospheric temperature is 15°C, calculate

    a) The rate of heat loss per m^2 of the surface area

    b) The temperature of the outside surface of the tank.

[Ans: 795W/ m^2, 94.5°C]

6) A thick walled tube of stainless steel with 20mm inner diameter and 40mm outer diameter is covered with a 30mm layer of asbestos insulation(K = 0.2W/mK). If the inside wall temperature of the pipe is maintained at 600°C and the outside insulation at 1000°C calculate the heat loss per meter of length. K_{ss}=200W/mK.

[Ans; 548.57W/m]

7) A steel pipe with 50mm outside diameter is covered with a 6.4mm asbestos insulation (K=0.166W/mK) followed by a 25mm layer of fiber-glass insulation (K=0.0485W/mK). The pipe wall temperature is 393K and the outside insulation temperature is 311K.

Calculate the interface temperature between the asbestos and fiber glass.

[Ans: 111.6°C]

8) An insulated steam pipe having outside diameter of 30mm is to be covered with two layers of insulation, each having thickness of 20mm. the thermal conductivity of one material is 5 times that of the other.
Assuming that the inner and outer surface temperatures of composite insulation are fixed, how much will heat transfer be increased when better insulation material is next to the pipe than it is outer layer.

[Ans: 50.9%]

9) Hot air at a temperature of 65°C is flowing through a steel pipe of 120mm diameter. The pipe is covered with two layers of different insulating materials of thickness 60mm and 40mm and their corresponding thermal conductivities are 0.24 and 0.4W/mK. The inside and outside heat transfer coeffs. are 60 and 12W/m²K. The atmosphere is at 20°C. Find the heat loss from 60m length of pipe.

[Ans: 3850W]

10) Determine the rate of heat flow through a spherical boiler wall which is 2m in diameter and 2cm thick steel (K= 58W/mK). The outside surface of boiler wall is covered with asbestos (K=0.116W/mK) 5mm thick. The temperature of outer surface and that of fluid inside are 50°C and 300°C respectively. Take inner film resistance as 0.0023K/W.

[Ans: 44.58kW]

11) A wire of 6.5mm diameter at a temperature of $60^{\circ}C$ is to be insulated by a material having K= 0.174W/mK. Convection heat transfer coeff= $8.722W/m^{2\circ}C$. The ambient temperature is $20^{\circ}C$. For maximum heat loss, what is the minimum thickness of insulation and heat loss per meter length? Also find percentage increase in the heat dissipation too.

[Ans: 16.7mm, 118.09%]

12) A furnace having inside dimensions 0.8*1.0*1.5m has brick walls 30cm thick. The temperature drop across the walls is $250^{\circ}C$ and thermal conductivity of the refractory brick is 5.25kj/m-h-deg. Workout shape factor for the furnace and determines the hourly heat loss by conduction. What saving in heat loss would occur if the rectangular furnace which has the same inside capacity and walls of same thickness.

[Ans: 40451kj/h, 14.15%]

Subject: HEAT TRANSFER   Class: 6thSemMech

Section- A

1. What do you mean by overall heat transfer coefficient?

2. What do you mean by critical thickness of insulation?

3. What is thermal diffusivity?

4. Explain shape factor for heat transfer by conduction.

5. Give examples of steady & unsteady heat flow.

6. Explain electrical analogy of heat transfer by conduction.

7. Explain factors effecting heat transfer coeff.

8. State assumption made for driving governing equation for fins.

9. Give boundary conditions when fin is losing heat at the tip.

10. Why taper fins are commonly used?

11. Define fin efficiency & fin effectiveness.

12. Give working principle of thermo metric well.

13. Why fins are not used for steam condensers?

14. How heat transfer coefficients effect the fin effectiveness?

15. State common types of fins.

16. How error appears while measure temperature with thermometric well?

17. Define Nusselt number & give its mathematical relation.

18. Define free & forced convection with examples.

19. Give classifications of heat exchanger.

20. What are the applications of heat exchangers?

21. Which is more efficient counter or parallel flow heat exchanger & why?

22. Give diagram showing temperature variation in tubular heat exchanger.

Section-B

1) A steel rod (K= 32W/mK), 12mm in diameter and 60mm long, with an insulated tip, is to be used as a spin. It is exposed to surroundings with a temperature of 60°C and a heat transfer coeff 55W/m²°C. The temperature at the base of fin is 95°C. Determine:
   a) The fin efficiency
   b) The temperature at the edge of the spine
   c) The heat dissipation

   [Ans: 62.18%, 72.66°C, 2.7W]

2) A mercury thermometer placed in oil well is required to measure temperature of compressed air flowing in a pipe. The well is 140mm long and is made of steel (K=50W/mK) of 1mm thickness. The temperature recorded by the well is 100°C while pipe wall temperature is 50°C. Heat transfer coefficient between the air and well wall is 30W/m²°C. Estimate true temperature of air.   [Ans: 103.46°C]

3) Water at 25°C flows across a horizontal copper tube 1.5 cm outer diameter with a velocity of 2m/s. Calculate heat transfer rate per unit length if the wall temperature is maintained at 75°C. Properties of water are: ρ=988kg/m³, K=0.648W/mK, μ=549.2×10⁻⁶ Ns/m², Cp= 4.174kj/kgK.

4) The flow rates of hot and cold water streams running through a parallel flow heat exchange are 0.2kg/s and 0.5kg/s respectively. The inlet temperatures on the hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C. If the individual heat transfer coeffs on both sides are 650W/m²°C, Calculate the area of the heat exchanger.   [Ans:2.65m²]

5) A counter-flow double pipe heat exchanger using superheated steam is used to heat water at the rate of 10500kg/h. The steam enters the heat exchanger at 180°C and leaves at 130°C. The inlet and exit temperature of water are 30°C and 80°C respectively. If overall heat transfer coeff from steam to water is 814W/m²K, calculate the heat transfer area. What would be the increase in area if the fluid flows were parallel?

   [Ans: 7.5m², 9.87%]

6) Oil (Cp=3.6kj/kgK) at $100°C$ flows at the rate of 30000kg/h and enters into a parallel flow heat exchanger. Cooling water (Cp= 4.2kj/kgK) enter the heat exchanger at $10°C$ at the rate of 50000kg/h. The heat transfer area is $10m^2$ and U=1000W/m²K. Calculate the following:

    a) the outlet temperatures of oil and water

    b) The maximum possible outlet temperature of water.

[Ans: $71.2°C$, $24.8°C$, $40.5°C$]

Subject: HEAT TRANSFER   **Class: 6th Sem Mechanical Engg.**

Section A

1. Explain film condensation & drop wise condensation.

2. Explain pool cooling &forced convection boiling.

3. Define absorptivity, reflectivity & transmissivity.

4. Explain the concept of black body & grey body.

5. State Planck's law.

6. Give Stephan-Boltzman law of radiations.

7. Explain radiation density, irradiation and radiosity.

8. Define Kirchoff''s law radiation heat transfer.

9. Define Lambert's cosine law &geometric factor.

10. Define radiosity & radiations shields.

11. Give applications of black body & grey body.

12. Define green-house effect & solar constant.

Section-B

1. Of the radiant energy 350 W/m^2 incident upon a surface 250 W/m^2 is absorbed, 60 W/m^2 is reflected and the remainder is transmitted through the surface. Workout the values for absorptivity, reflectivity and transmissivity for the surface material.

2. State the parameters which affect the shape factor. Calculate the shape factor for the following configuration:

    a. Long tube with cross-section of an equilateral triangle.

    b. Black body inside a black enclosure.

3. A furnace emits radiation at 2000 K. Treating it as a black body radiation, calculate the

a) Monochromatic radiant flux density at 1 µm wavelength,

b) Wavelength at which emission is maximum.

c) Total emissive power

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Two marks Questions (Combined)

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2. What are the different modes of heat transfer?

3. Differentiate between conduction & convection heat transfer.

4. Explain electrical analogy of heat transfer.

5. What do you mean by over all heat transfer coefficient?

6. What do you mean by critical thickness of insulation?

7. Drive units for heat conductivity & heat transfer coefficient.

8. What is thermal diffusivity?

9. Explain shape factor for heat transfer by conduction.

10. What is Fourier law of heat transfer by conduction?

11. Give examples of steady & unsteady heat flow.

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24. State Biot number.

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26. How error appears while measure temperature with thermometric well?

27. Define Nusselt number & give its mathematical relation.

28. Define free & forced convection with examples.

29. State Newton law of cooling.

30. How boundary layers formed

31. Give classifications of heat exchanger.

32. What are the applications of heat exchangers?

33. Which is more efficient counter or parallel flow heat exchanger & why?

34. Give diagram showing temperature variation in tubular heat exchanger.

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73. Give applications of black body & grey body.

74. How intensity of radiations effect the heat transfer?

75. Define green house effect & solar constant.