ROLL NO.	

PRESIDENCY UNIVERSITY, BENGALURU
SCHOOL OF ENGINEERING

Max Marks: 80 | Max Time: 120 Min. | Weightage: 40 %

END TERM FINAL EXAMINATION

I Semester AY 2017-18 | Course: **MEC 209 HEAT & MASS TRANSFER** | 20 DEC 2017

Instructions:

i. Write legibly.
ii. Lengthy answers attracts penalty.
iii. Use of prescribed heat transfer data book is permitted
iv. Scientific and non-programmable calculators are permitted.

Part A

[4 Q x 5 M= 20 Marks]

1. Define the following:
   a. Effectiveness
   b. Fouling factor
2. Distinguish between Grey body and Black body. Explain the concept of a Black body.
3. Distinguish between mass transfer and heat transfer.
4. Define Stanton and Nusselt number? What is the physical significance of each? How are they related with each other?

Part B

[3 Q x 10 M= 30 Marks]

5. a. Calculate the shape factor $F_{1\text{-}2}$ for the given figure 1.

   b. If surface 1 is maintained at 1000ºC and surface 2 is maintained at 500ºC, what is the heat transfer from surface 1 to 2?

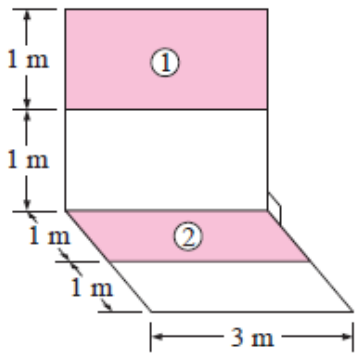

Figure 1

6. In a typical application of cooling in Chemical Industry, one shell pass and two tube pass heat exchanger is used. Water at the rate of 68 kg/min is (shell side) and heated from 35°C to 75°C by an oil (tube side) having a specific heat of 1.9 kJ/kg.°C. The oil enters the exchanger at 110°C and leaves at 75°C. The overall heat-transfer coefficient is 320 W/m^2.°C. Assuming a counter-flow arrangement, calculate the heat-exchanger area.
7. A circular hot plate, 15 cm in diameter, is maintained at 150°C in atmospheric air at 20°. Calculate the free-convection heat loss when the plate is in a horizontal position.

Part C

[2 Q x 15 M= 30 Marks]

8. A counter-flow double-pipe heat exchanger is to heat water from 20^{0}C to 80^{0}C at a rate of 1.2 kg/s (figure 2). The heating is to be accomplished by geothermal water available at 160^{0}C at a mass flow rate of 2 kg/s. The inner tube is thin-walled and has a diameter of 1.5 cm. the overall heat transfer coefficient of heat exchanger is 640 W/m^2.K. Using the effectiveness method determine the length of heat exchanger required to achieve the desire heating.

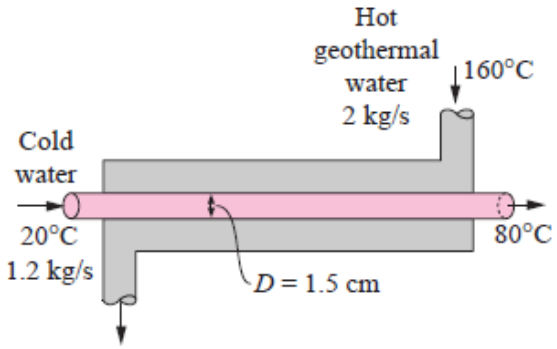

Figure 2

9. On a motherboard, an array of ICs (length 20 mm each and 5 mm width) are soldered to perform routine computational task. While operation, one of the ICs maintained at constant wall temperature of 50°C is releasing heat to the surrounding air at 20°C. An exhaust cooling fan is used to create a circulation at a speed of 2 m/s.
    a. Calculate the heat rejected to the surrounding from one IC.
    b. If 100 such ICs are present, what is the total heat transfer takes place?
    c. Compute the shear stress at the wall of one of the ICs using the analogy between fluid friction and heat transfer.

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Max Marks: 40 | Max Time: 60 Mins | Weightage: 20 %

TEST 1

I Semester 2017-2018 | Course: **MEC 209 Heat and Mass Transfer** | 18 SEPT 2017

Instructions:

i. Write legibly. Lengthy answer attracts penalty.
ii. Use of heat and mass transfer data book is permitted.
iii. Scientific and non-programmable calculator is permitted.

Part A

(3Q x 3 M= 09 Marks)

1. Define Fourier Number. State its significance. At what condition, Lumped Heat Capacity Method can be useful?

2. How heat is conducted through a solid? Write down the expression for two-dimensional transient-state heat conduction without heat sources.

3. Define fin efficiency. Write down the expression for Universal heat transfer coefficient for the arrangement shown in fig. 1

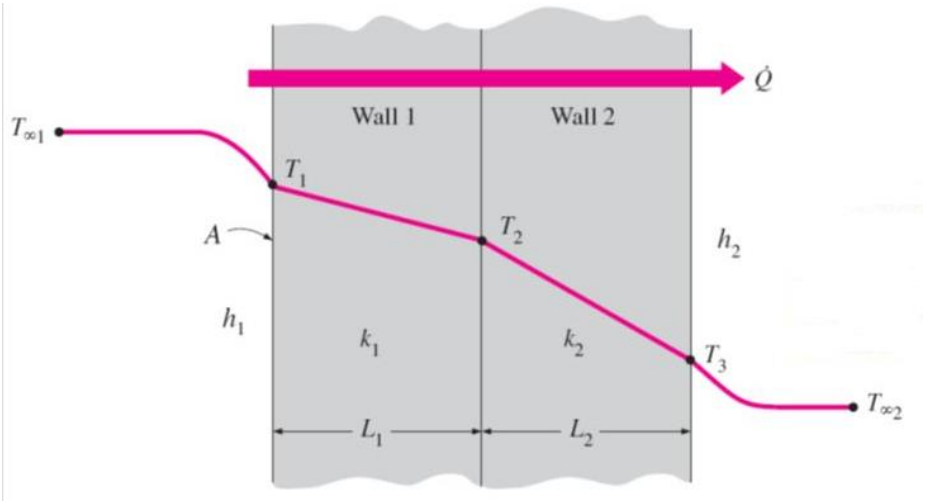

Fig. 1

Part B

(2 Q x 8 M= 16 Marks)

4. Consider, one side of a plane furnace wall is maintained at 100 ^{0}C, while the other side is exposed to a convection environment having T = 10 ^{0}C and h = 10 W/m^2.^{0}C. The wall has a thermal conductivity of k = 1.6 W/m.^{0}C and thickness of 40 cm. Calculate

a. The heat transfer rate through the wall per unit area.
b. The temperature on the other side of the plane furnace wall.

5. A foreman in a workshop heated a sample of an aluminum ball (r = 1 cm) at 400 ^{0}C and then suddenly quenched it in a cooling water beaker maintained at 25 ^{0}C. The heat transfer coefficient is 58 W/m^2.^{0}C. Using Lumped Heat Capacity method, calculate the time required for the sample to cool to 200 ^{0}C.

Part C

(1 Q x 15 M= 15 Marks)

6. Several triangular fins were protruded from a 100 cm length and 25 cm wide rectangular base plate. Each fin has a length of 5 cm, depth of 25 cm and thickness of 4 mm and is constructed using a material having k = 23 W/m.^{0}C. The fin is exposed to the surrounding with a convection coefficient of 20 W/m^2.^{0}C and a temperature of 40 ^{0}C. The base of the fin is maintained 200 ^{0}C.

a. Calculate the heat loss rate from fin. (6M)
b. If the pitch distance between each fin is 6 cm, what is the maximum number of fins required to cover entire rectangular base when placed across its length. (2M)
c. Calculate combined heat loss rate from all the fins. (2M)
d. If all fins are removed and the whole rectangular base plate is exposed to the same surrounding temperature, calculate and comment on the heat transfer rate. (5M)