KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 3rd Year 1st Term Online Examination, 2020

ME 3105 / ME 3205

(Heat Transfer I)

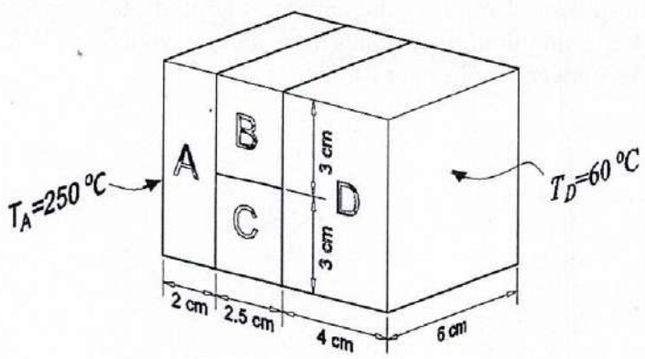
Time: 1 Hour 30 Minutes | Full Marks: 120

N.B.: i) Answer any TWO questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION-A

1(a) A solid cylinder of radius $r = R$ in which energy is generated by a rod heater placed at the center with a constant rate of g_0 W/m^3 . The boundary surface at $r = R$ of the cylinder is maintained at a constant temperature T_α. Develop an expression for the one-dimensional, radial, steady-state temperature distribution $T(r)$ and heat flux $q(r)$. 18

1(b) A section of a composite wall with the dimensions shown in the figure has uniform temperatures of 250°C and 60°C over the left and right surfaces, respectively. If the thermal conductivities of the wall materials are: $k_A = 80$ W/mK, $k_B = 50$ W/mK, $k_C = 55$ W/mK, and $k_D = 30$ W/mK, determine the rate of heat transfer through this section at the wall. 12



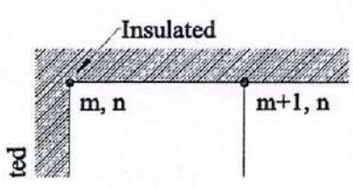
2(a) A tube with OD of $D = 4$ cm is maintained at a uniform temperature and is covered with an insulateres tube cover having thermal conductivity $k = 0.20$ W/(m.°C) in order to heat loss. Heat is dissipated from cover outer surface by natural convection ($h_o = 14$ W/m^2.°C) into the ambient air at constant temperature. Determine the critical thickness of insulation and the ratio of the heat loss from the tube with insulation to that without any insulation for the thickness of insulation equal to that at the critical thickness. 15

2(b) An aluminum rod 2 cm in diameter and 30 cm long protrudes from a wall that is maintained at 250°C. The rod is exposed to an environment at 10°C. The convective heat transfer coefficient is 10 W/m^2. Calculate the heat lost by the rod. $K = 250$ W/(m.°C). 15

3(a) What is the effect of contact resistance on heat transfer? 07

3(b) How do you calculate the fin efficiency of a rectangular fin? 07

3(c) Derive an expression for the nodal equation of node (m, n) as shown in figure under steady-state condition. 16



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SECTION-B

4(a)	What are the features of blackbody over real body?	07
4(b)	"Emissive power of a blackbody depends upon its temperature." Explain it with the help of related laws.	08
4(c)	Using the lumped system analysis, determine the time required for a solid steel ball of diameter $D = 5$ cm [$\rho = 78.33$ kg/m^3, $c_p = 0.45$ kJ/kg.°C, and $k = 90$ W/m.°C] to cool from 700 to 100°C if it is exposed to an airstream at 45°C having a heat transfer coefficient $h = 120$ W/m^2.°C.	15
5(a)	Distinguish between direct and diffuse solar radiation.	07
5(b)	Define and explain Wien's displacement law of radiation.	08
5(c)	Derive the reciprocity relation for the radiation exchange between finite surfaces.	15
6(a)	Draw the radiation network for the heat exchange in a three zone enclosure with a reradiating surface.	07
6(b)	What is meant by radiation shield? Show that the radiation exchange can be reduced 50% if a shield of equal emissivity placed between the surfaces.	11
6(c)	In a test room of 4 m×4 m×4 m, the ceiling is kept at 90°C while the walls and floor are at 15°C. Assuming that all surfaces have an emissivity $\varepsilon = 0.7$, determine the rate of heat transfer between ceiling and floor.	12

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ME 3119

(Statistics & Quality Control)

Time: 1 Hour 30 Minutes Full Marks: 120

N.B.: i) Answer any TWO questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION-A

1(a) What is meant by dispersion? What are the ways to measure it? Prove that the standard deviation $\sigma = [\sum x^2 f(x) - \mu^2]^{1/2}$, where the symbols have their usual meanings. 15

1(b) What are meant by moment and skewness? Calculate the skewness (a_3) and peakedness (a_4) for the following data. 15

i	x_i	f_i
1	10	2
2	15	3
3	20	4
4	25	1

2(a) If the probability that an individual will suffer a bad reaction from a COVID-19 vaccine is 0.0015, determine the probability that out of 3000 individuals – (i) exactly 5, (ii) more than 4, individual will suffer a bad reaction. 12

2(b) If 10% of bolts produced by a machine are defective, determine the probability that out of 5 bolts chosen at random – (i) 1 bolt will be defective, (ii) less than 2 bolts will be defective. 12

2(c) What are meant by the following terms – (i) Null hypothesis, (ii) Type-I error, (iii) Type-II error? 06

3(a) A chemical engineer determines the percentage of sulfur in tires. For 100 days the number of days which violated the 4% per tire limit is given below. Use the χ^2 goodness-of-fit test to determine whether the data follows Poisson distribution or not. 15

Violations per day	0	1	2	3	4	5	6
Number of days	33	44	10	5	5	2	1

3(b) The time between the arrival of SMS in your mobile phone is exponentially distributed with a mean two hours, 15

(i) What is the probability that you do not receive a message during a two hour period?
(ii) If you have not had a message in the last four hours, what is the probability that you will receive a message within next two hours?
(iii) What is the expected time between your fifth and sixth message?

SECTION-B

4(a) What is control chart? Write down the rules used to interpret control chart. 10

4(b) Sample of $n = 6$ items each are taken from a manufacturing process at regular intervals. A quality characteristics is measured and $\bar{X}$ and R values are calculated for each sample. After 50 sample, the results are $\sum_{i=1}^{50} \bar{X}_i = 2000$ and $\sum_{i=1}^{50} R_i = 250$ 20

(i) Compute control limits for the $\bar{X}$ and R control chart.
(ii) Calculate natural tolerance limits of the process.

5(a) What are situations where acceptance sampling is useful? Mention the merits and demerits of acceptance sampling. 10

5(b) Explain double sampling plan with flow chart. 20

6(a) Differentiate between quality design and quality conformance. 10

6(b) A double sampling plan with $N = 10{,}000$, $n_1 = 50$, $c_1 = 2$, $n_2 = 100$, $c_2 = 4$, compute – 20

(i) Probability of acceptance after the 1st sampling
(ii) Probability of going for second sampling
(iii) The probability of acceptance assuming 2% defective lot.