KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 3rd year 1st Term Examination, 2017
ME 3105
(Heat Transfer I)

Time: 3 Hours. Total Marks: 210

N.B. i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Necessary Charts may be supplied on request.
iv) Assume reasonable data if any missing.

SECTION - A

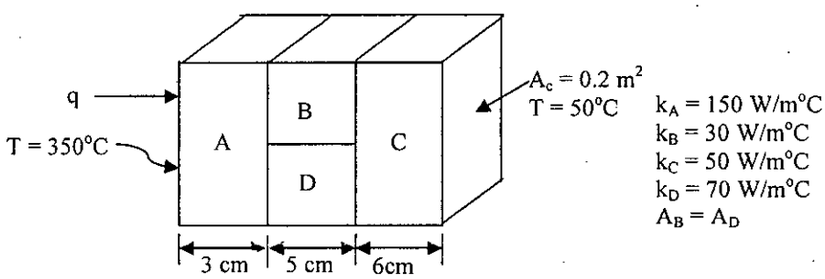
1(a) How does heat transfer differ from thermodynamics? 06

1(b) Define thermal conductivity and explain its significance in heat transfer. 09

1(c) Derive the general three dimensional heat conduction equation in rectangular coordinates. 20

2(a) Derive an expression for one-dimensional radial, steady-state temperature distribution and heat flux in a solid cylinder of radius 'r' in which energy is generated at a constant rate of q_0 w/m^3 while the boundary surface is maintained at a constant temperature T_∞. 15

2(b) Find the heat transfer per unit area through the composite wall as shown in figure. Assume one-dimensional heat flow. 20

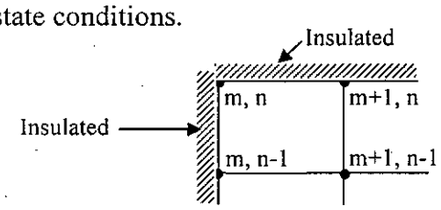


3(a) What is meant by thermal contact resistance? 05

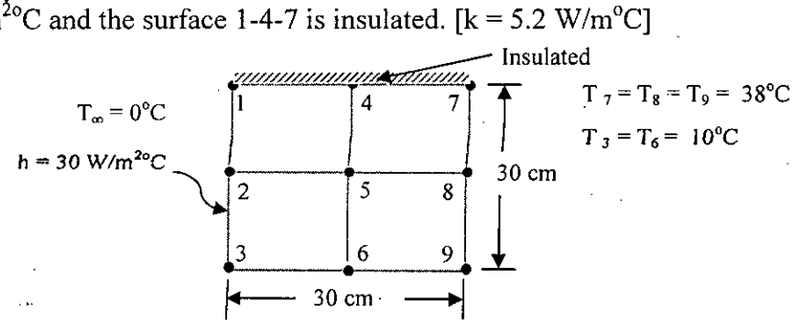
3(b) Describe the concept of critical thickness of insulation. Derive an expression for the critical radius of insulation when it is put outside of a small hollow pipe. 15

3(c) What is fin efficiency? Derive an expression for heat flow through a long circular fin when the fin tip approaches the surrounding fluid temperature. 15

4(a) Using the finite difference technique derive an expression for the nodal equation of node (m, n) under steady-state conditions. 15



4(b) Using the numerical technique, compute the temperatures at nodes 1, 2, 4 and 5 for steady-state condition. The convection heat transfer coefficient at surface 1-2-3 is 30 W/m^2°C and the surface 1-4-7 is insulated. [k = 5.2 W/m°C] 20



SECTION – B

5(a) What are the assumptions considered for Lumped-heat capacity analysis? Derive an expression of temperature distribution within a hot solid metal when it is suddenly dropped to a cold environment using lumped-heat capacity method. 18

5(b) An orange of diameter 10 cm is initially at a uniform temperature of 30°C. It is placed in a refrigerator in which the air temperature is 5°C. If the heat transfer coefficient between the air and the surface of the orange is 60 $W/m^{2o}C$, determine the time required for the center of the orange to reach 10°C. [Assume, k = 0.59 W/m°C and $\alpha = 1.4\times10^{-7}$ m^2/s]. 17

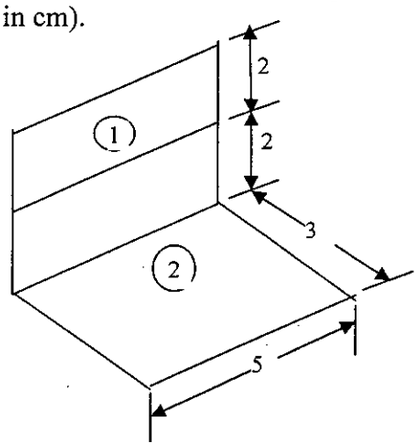
6(a) What is a black body? Show that the spectral emissive power of a black body is π-times its spectral radiation intensity. 12

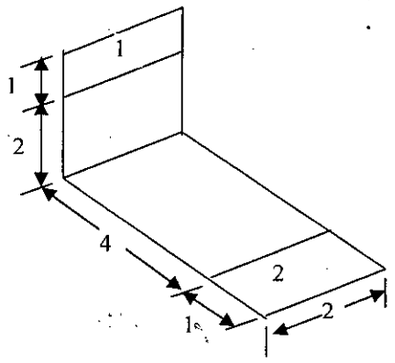
6(b) Explain Wien's displacement law. 08

6(c) Consider an enclosure consisting of two parallel infinite opaque plates. Surfaces 1 and 2 are gray, and are kept at uniform temperatures T_1 and T_2, with emissivities ε_1 and ε_2, reflectivity ρ_1 and ρ_2, respectively. Develop an expression for radiation exchange between the surfaces. 15

7(a) Using radiation network method, derive an expression for radiation heat exchange between two long parallel plates. 17

7(b) Determine the radiation shape factors F_{1-2} for the situations shown below (dimensions are in cm). 18

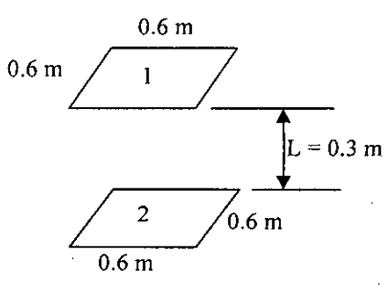




8(a) Show that the radiative heat flow reduces to one-half, if one radiation shield is used between two infinite parallel plates. 08

8(b) Differentiate between radiation intensity, irradiation and radiosity. 09

8(c) Two aligned, parallel square plates 0.6m by 0.6m are separated by L = 0.3m as shown. Plate 1 is maintained at T_1 = 1000K and has an emissivity ε_1 = 0.70. Plate 2 is maintained at T_2 = 500K and has an emissivity ε_2 = 0.50. The plates are exposed through the opening between them into an ambient regarded as black medium at T_∞ = 300K. Sketch the radiation network for the two surfaces and the ambient. Calculate the heat transfer between the plates and heat loss to the ambient. 18



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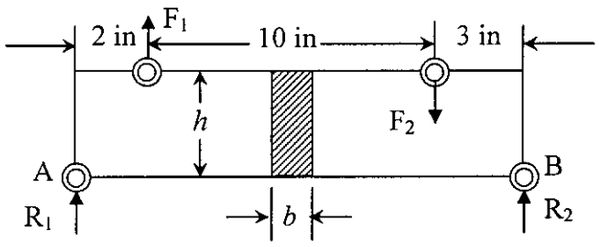
KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 3rd year 1st Term Examination, 2017
ME 3117
(Machine Design I)

Time: 3 Hours. Total Marks: 210

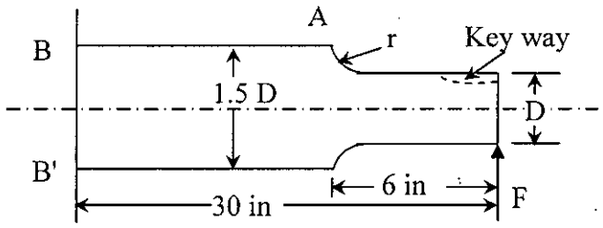
N.B. i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION - A

1. A bar is subjected to loads F_1 = 2000 lb and F_2 = 3000 lb as shown in Fig. The cross section of the bar is defined by h = 3b; and the factor of safety based on ultimate strength, N = 3.5. Determine the dimensions 'h' and 'b' if the bar is made of (a) AISI C1020 annealed steel and (b) AISI C1040, as rolled. 35



2. An axle (non-rotating) is to be machined from AISI 1144, OQT 1000°F to the proportions shown, with a fillet radius $r \approx 0.30D$; F varies from 500 lb to 1000 lb; the supports are to the left of BB′, not shown. Let N = 2.5 (Soderberg line). (a) At the fillet, compute D and maximum tensile stress; (b) Compute D at section BB′; (c) Specify suitable dimensions, keeping the proportions same, would a smaller diameter be permissible if the fillet were shot-peened? 35



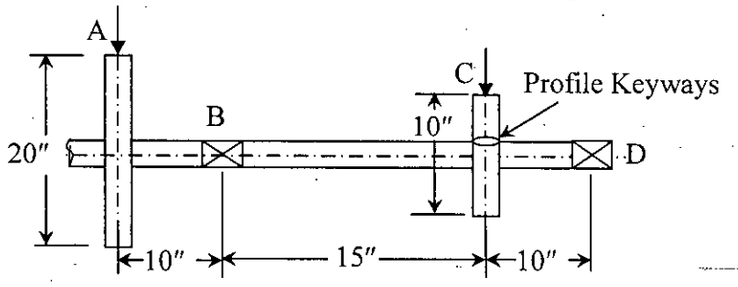
3. A compressor of size, 10 × 18 in., 10 studs, UNC; made of C1118, as rolled; gas pressure is 185.3 psig. The initial tension in the bolts, assumed to be equally loaded, is such that a cylinder pressure of 285.3 psig is required for the joint to be on the opening. Let D_e = 2D. (a) N = 2 on the Soderberg criterion, what bolt size is required? (b) Compute the torque required for the specified initial tension when no proof stress are available. 35

4. A coil spring is to be used for the front spring of an automobile. The spring is to have a rate of 4 lb/in., an inside diameter of $4^3/_{64}$ in., and a free length of 14⅛ in., with squared and ground ends. The material is to be oil tempered chrome-vanadium steel. Decide upon the diameter of wire and the number of free coils for a design load on F = 2500 lb. Be sure 'solid stress' is all right. How much is the pitch angle? 35

SECTION – B

5. A hollow circular column made of AISI 1030, as rolled, is to support a load of 15,000 lb. Let L =40 in., $D_i = 0.65D_o$ and N = 2.5. Determine D_o by (a) using either Euler's or the parabolic equation; (b) using straight line equation; (c) what would be the factor of safety by the Secant formula for dimensions found in (a)? 35

6. A cold-finished shaft, AISI 1141, is to transmit power that varies from 200 to 100 and back to 200 hp in each revolution at a speed of 600 rpm. The power is received by a 20 in. spur gear A and delivered by a 10 in. spur gear C. The tangential forces have each been converted into a force (A and C shown) and a couple (not shown). The radial component R of the tooth load is to be ignored in the initial design. Let N = 2 and, considering varying stresses with the maximum shear, compute the shaft diameter, 35



7. A square-threaded screw 2 in. in diameter is used to exert a force of 24,000 lb in a shaft straightening press. The maximum unsupported length of the screw is 16 in. and the material is AISI C1040, annealed. (a) What is equivalent compressive stress in the screw? Is this a satisfactory value? (b) What torque is necessary to turn the screw against the load for f = 0.15? (c) What is the efficiency of the screw? (d) What torque is necessary to lower the load? 35

8. A $1^{11}/_{16}$ in. shaft rotating at 200 rpm, carries a cast-iron gear keyed to it by a ¼ ×1¼ in. Woodruff key; shaft material is cold-finished SAE 1045. The power is transmitted with smooth loading. What horse power may be safely transmitted by the key? (a) If it is made of cold drawn SAE 1118. (b) If it is made of SAE 2317, OQT 1000°F. (c) How many keys of each material needed to give capacity of 25 hp? Specify a choice. 35

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 3rd year 1st Term Examination, 2017
ME 3121
(Numerical Computation for Mechanical Engineers)

Time: 3 Hours. Total Marks: 210

N.B. i) Answer any THREE 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) Discuss linear interpolation and extrapolation with example. 06

1(b) Derive Newton's backward interpolation formula in its standard form. 14

1(c) Find $f(x)$ as a polynomial in x using Newton's general interpolation formula from the following table. Also find the value of $f(x)$ when $x = 1$. 15

x	-1	0	3	6	7
$f(x)$	3	-6	39	822	1611

2(a) Show the relation between Simple and Divided differences. 12

2(b) Derive the third Gauss formula for interpolation. 10

2(c) Evaluate $\int_0^{\pi/2} \sin\theta \, d\theta$. Use $h = \pi/12$ and compare the results by using Trapezoidal and Simpson's $1/3$ Rule. 13

3(a) What is Newton-Raphson method? Discuss the geometric significance of Newton-Raphson method. When this method is not wise to use? 18

3(b) Solve the system of nonlinear equations by method of iteration. 17

$$x^2 + y = 11, \quad x + y^2 = 7$$

4(a) What are the methods of solution for linear algebraic equation? Describe Gauss Elimination method. 16

4(b) Solve the following system of equations by Gauss-Seidel method. 19

$$\begin{bmatrix} 17 & 65 & -13 & 50 \\ 12 & 16 & 37 & 18 \\ 56 & 23 & 11 & -19 \\ 3 & -5 & 47 & 10 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} = \begin{bmatrix} 84 \\ 25 \\ 36 \\ 18 \end{bmatrix}$$

SECTION – B

5(a) What is ordinary differential equation? Deduce Euler's formula and also its modified form for the solution of ordinary differential equation. 20

5(b) Determine the largest eigenvalue and the corresponding eigenvector of the following matrix. 15

$$\begin{bmatrix} 10 & -2 & 1 \\ -2 & 10 & -2 \\ 1 & -2 & 10 \end{bmatrix}$$

6(a) Use the Forth-order Runge-Kutta method to solve $\frac{dy}{dx} = 1 + y^2$, where $y = 0$ when $x = 0$. Find $y(0.2)$, $y(0.4)$ and $y(0.6)$. 20

6(b) Solve the ordinary differential equation $\frac{dy}{dx} = \frac{y-x}{y+x}$, $y = 1$ when $x = 0$ using Picard's method to find $y(0.2)$. 15

7(a) Describe Successive Over-relaxation (SOR) method. 05

7(b) What are the types of boundary condition? Distinguish between explicit and implicit scheme. 06

7(c) Describe Crank-Nicolson method for solving partial differential equation. 10

7(d) The values of y and their corresponding values of x are shown in the table below – 14

x	0	1	2	3	4
y	2	3	5	4	6

(i) Find the regression line $y = ax + b$

(ii) Estimate the value of y when $x = 10$.

8(a) Find the condition of stability for the solution of a numerical problem in Explicit scheme. 19

8(b) Heat is conducted through a rod of 2 cm diameter and 20 cm long in steady state where heat is generated within the rod at 8.2×10^7 W/m^3. At length = 0, the temperature is maintained at 200°C, while at length = 20 cm heat dissipates by convection with heat transfer coefficient 250 W/m^{2o}C into an ambient at temperature of 50°C. Find the temperature distribution along the rod dividing it into 5 intervals. Assume thermal conductivity of rod material as 30 W/m°C. 16

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 3rd year 1st Term Examination, 2017
ME 3219 (Old)
(Statistics and Quality Control)

Time: 3 Hours. Total Marks: 210

N.B. i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Necessary Charts may be supplied on request.
iv) 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. 20

i	*Xi*	*fi*
1	10	2
2	15	3
3	20	4
4	25	1

2(a) One bag contains 4 white balls and 4 black balls and a second bag contains 3 white ball and 4 black balls. One ball is drawn from the first bag and placed unseen in the second bag. What is the probability that a ball now drown from the second bag is black? 12

2(b) A solution possibly contains two toxic chemicals. In 100 randomly mixed samples, 45 contain chemical-1, 40 contain chemical-2 and 35 contain both. If a sample is selected from the 100, what is the probability of finding that (i) the solution is toxic; (ii) chemical-1 only; (iii) neither chemical? 13

2(c) Suppose the probability of an item produced by a certain machine will be defective is 0.12. Find the probability of 10 items that will contain (i) at most one defective and (ii) maximum 3 defective. 10

3(a) Write down the properties of Poisson distribution. When binomial distribution can be approximated by Poisson distribution? Explain. 08

3(b) The number of defects found in a glass bottles is shown in table below. A bottle is selected at random and inspected. Calculate the probability that there will be at least 2 defects. 12

Number of defects	0	1	2	3	4	5
Frequency	10	12	6	2	1	1

3(c) A particular gear is expected to fail according to the exponential distribution at a rate of 0.0015 failures per hour of operation. Compute – 15
(i) The mean life for a gear and
(ii) The number of gears out of 50 which can be expected to be replaced prior to 500 hours.

4(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 x^2 goodness-of-fit test to determine whether the data follows Poisson distribution or not. 20

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

4(b) The time between the arrival of SMS in your mobile phone is exponentially distributed with a mean of 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

5(a) What are the various common patterns observed in control chart? Describe them. Also, mention the possible causes of these patterns. 12

5(b) Sample of n = 5 are taken from a manufacturing process every hour. A quality characteristics is measured and $\bar{X}$ and R values are calculated for each sample. After 25 samples have been analyzed, the results are: 23

$$\sum_{i=1}^{25} \bar{X}_i = 662.50 \text{ and } \sum_{i=1}^{25} R_i = 9.00$$

The quality characteristics are normally distributed.

(i) Calculate the control limits for the $\bar{X}$ and R control charts.
(ii) Assume that both charts exhibit control. If the specifications are 26.40 ± 0.50. Estimate the fraction nonconforming.
(iii) If the mean of the process were 26.40, what fraction nonconforming would result?

6(a) What are the 'Magnificant seven' for quality improvement? 05

6(b) Explain 'Pareto Chart' and 'Cause and Effect Diagram' in details. 20

6(c) List the 'Sensitizing Rules' that are widely used in practice for control charts. 10

7(a) What is acceptance sampling? What are the situations where acceptance sampling is useful? Also mention the merits and demerits of acceptance sampling. 14

7(b) What are meant by producer's risk and consumer's risk? If you are a producer, what is your objective in designing a single sampling plan? Explain. 06

7(c) Suppose that a single sampling rectifying inspection plan with n = 150 and c = 2 is being used for receiving items where the vendor ships the product in lots of size N = 2000. Draw the AOQ curve and find the AOQL. 15

8(a) Explain the double sampling plan with the help of flow diagram. 08

8(b) What is meant by MIL STD 105E. Explain. 07

8(c) 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.

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