B.Sc. Eng. (MCE) 2st Semester 25 October 2018

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester, A.Y. 2017-2018
Course Code: Chem 4215 — Time : 3 hours
Course Title: Chemistry of Engineering Materials — Full Marks : 100

There are **8 (eight)** Questions. Answer any **6 (six)** of them.
Marks in the Margin indicate the full marks. The symbols have their usual meaning.

1 a) What do you understand by priming and foaming? Describe their effects in a boiler. **6**

b) Write a short note on the following terms: **$6\frac{2}{3}$**
(i) Sedimentation (ii) Coagulation (iii) Filtration.

c) Zeolite softener was completely exhausted by the treatment of water. It was then regenerated by passing 1000 litres of NaCl solution containing 50 g per litre NaCl. Calculate the amount (in litre) of sample water of hardness 300 ppm that can be softened by this softener. **4**

2 a) What is microbiological corrosion? Write down the reactions involves during microbiological corrosion in water and in the soil. **5**

b) How corrosion can be prevented by sacrificial method and anodic protection method? **$5\frac{2}{3}$**

c) Write short notes on the following terms: **6**
(i) Differential aeration corrosion (ii) Dezincification (iii) Corrosion fatigue.

3 a) Define Portland cement. Write the general composition of Portland cement. Write the symbols used for representing four basic components of cements. **4**

b) Discuss the theories of setting and hardening of cement with chemical reaction involved. **$8\frac{2}{3}$**

c) What are the calcareous and argillaceous materials? Give examples of each. **4**

4 a) Describe the different steps of manufacturing of glass articles. **$8\frac{2}{3}$**

b) Write notes on the following **8**
(i) Glass former (ii) Refining agents (iii) Stabilizer (iv) Cullet

5	a)	How the following polymer can be synthesized from its monomer? (i) PVC (ii) Bukelite (iii) Melamine (iv) Nylon-6,6	6
	b)	What is LDPE? Discuss the mechanistic path way of the cationic addition polymerization.	5
	c)	Describe different types of additives that are used for the processing of polymer?	$5\frac{2}{3}$
6	a)	Write a short note about clay and sand as a raw materials of ceramic wares.	5
	b)	Describe the chemical conversions that occur during firing of ceramics wares.	$6\frac{2}{3}$
	c)	Describe the process of glazing of ceramic wares and it's important.	5
7	a)	What is rubber? Mention its important properties that make it suitable for the manufacture of valuable goods.	6
	b)	Show by chemical equations how would you detect the following functional moieties present in the natural rubber? (i) Natural rubber is a hydrocarbon (ii) It contains carbon-carbon double bond (iii) It contains isoprene unit (iv) It contains cis-carbon-carbon double bond.	6
	c)	What is vulcanization of rubber? How vulcanization can be carried out? Why it is important?	$4\frac{2}{3}$
8	a)	Define lubricant and lubrication. State the functions of lubricant.	$4\frac{2}{3}$
	b)	Describe the different steps of the industrial manufacturing process of refractory material.	6
	c)	Write notes on the following (i)Refractoriness (ii) Softening temperature (iii) Spalling	6

B Sc. Eng. (ME)(2nd Semester) 23 October, 2018

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Final Semester Examination Summer Semester, A.Y. 2017-2018

Course Code: Math 4211 Time : 3 hours

Course Title: Differential Equations and Special Functions Full Marks: 200

There are **8 (Eight)** Questions. Answer any **6 (Six)** of them. All Questions carry equal Marks. Programmable calculators are not allowed. Do not write on this question paper. The Symbols have their usual meaning.

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1. a) Plot the solution curves and slope field for the differential equation for the appropriate ranges for variables x and y

$$y' + y = x + 2$$

b) Find the general solution to the following differential equation

$$(2x+1)y' + y = (2x+1)^{\frac{3}{2}}$$

c) A tank originally contains 100 liters of pure water. Salt water with a concentration of 2 kg/L is pumped into the tank at 3 L/min, and the well-mixed solution is drained at the same rate.
(i) Set up an initial value problem describing the situation. Be sure to explain all of your variables.
(ii) Solve the problem in part c(i) to find the amount of salt in the tank at any time t.
(iii) What is the limiting concentration of salt in the tank?

2. a) Find the solution to the following constant coefficient nonhomogeneous differential equation:

$$y'' + 2y' + 5y = 4e^{-t}\cos(2t), y(0) = 1,\ y'(0) = 0.$$

b) Suppose that a mass weighing 10 lb stretches a spring 2 in. If the mass is displaced an additional 2 in. and is then set in motion with an initial upward velocity of 1 ft/s, determine the expression of the position of the mass at any later time. Also determine the period, amplitude, and phase of the motion.

3. a) (i) Do you think that series solution is an important tool to solve differential equation? Justify your answer.
(ii) Solve the Bessel's differential equation by the Frobenius Method.

b) (i) Discuss the logic of backgrounds of the trail function in part 3a(ii).
(ii) Prove that $J_{-n}(x) = (-1)^n J_n(x)$ where n is a positive integer and where $J_n(x)$ is the Bessel's function.

(ii) Prove that $J_{1/2}(x) = \sqrt{\frac{2}{\pi x}}\sin x$

4. a) (i) Write down the Legendre's functions of the first kind.
(ii) Express $f(x) = 4x^3 + 6x^2 + 7x + 2$ in terms of Legendre Polynomials.

b) (i) Define Gama and Beta functions.
(ii) Express Beta function in terms of Gama function.

(iii) From the relationship between gamma and beta functions find the value of $\left|\frac{1}{2}\right.$.

5. a) (i) Find the Laplace transform of the function graphed in figure Q 5(a).

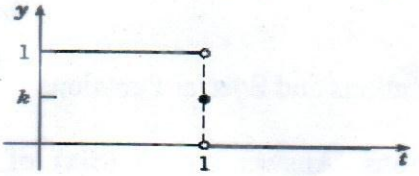

Fig.: Q5 (a)

(ii) Show the relationship $L^{-1}\left\{\frac{1}{s}\exp\left(-\frac{1}{s}\right)\right\} = J_0\left(2\sqrt{t}\right)$

where $J_0(t)$ is the Bessel's function defined as $J_0(2\sqrt{t}) = \sum_{n=0}^{\infty} \frac{(-1)^n}{(n!)^2}\left(\sqrt{t}\right)^{2n}$

b) The square wave function $g(t)$ is shown in figure Q5 (b) and its mathematical expression can be constructed by Step functions as

$$g(t) = 2\sum_{n=0}^{\infty}(-1)^n u(t-n) - u(t-0)$$

Prove that $$L\{g(t)\} = \frac{1-\exp(-s)}{s(1+\exp(-s))} = \frac{1}{s}\tanh\frac{s}{2}$$

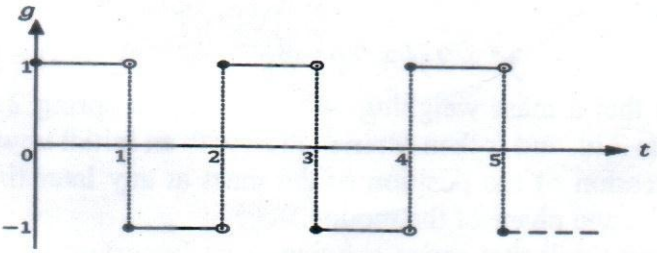

Fig.: Q5 (b)

6. a) Find the inverse Laplace transform of

$$(i)\ \frac{s^2+1}{s^3-2s^2-8s} \quad (ii)\ \frac{1}{s^2(s-a)}$$

b) Compute the Laplace Transformation of the following triangular wave function shown in figure Q 6(b)

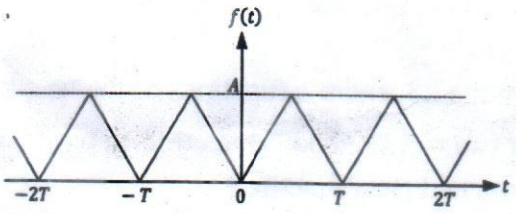

Fig.: Q6 (b)

7. a) Use Convolution theorem to prove the following identity

$$L^{-1}\left\{\frac{1}{(s-1)\sqrt{s}}\right\} = \exp(t)\operatorname{erf}\left(\sqrt{t}\right)$$

where L^{-1} denotes an inverse Laplace Transformation and *erf(x)* is the "error function" defined by $erf(x) = \frac{2}{\sqrt{\pi}}\int_0^x \exp(-u^2)du$

b) A system of two blocks connected by two springs and an external force $f(x)$,descrived in the figure Q 7(b) and modeled by the followinf differential equation system

$$\begin{cases} 2x'' = -6x + 2y \\ y'' = 2x - 2y + 40\sin 3t \\ x(0) = x'(0) = y(0) = y'(0) = 0 \end{cases}$$

Use Laplace Transformation find the genaral solution of the system.

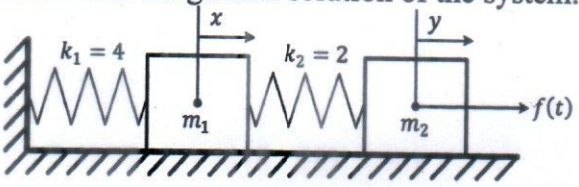

Fig.: Q 7(b)

8. a) Suppose that a rod of length $L = 50$ cm is immersed in steam until its temperature is $u_0 = 100^0C$ throughout. At time $t = 0$, its lateral surface is insulated and its two ends are imbedded in ice at 0^0C.
(i) Write down the boundary value problem for this rod's temperature function $u(x, t)$.
(ii) Solve the partial differential equation in part (i).
(iii) Calculate the rod's temperature at its midpoint after half an hour if thermal diffusivity constants is 0.15 cm^2/s.

b) A string is stretched and fastened to two points L apart. Motion is started by displacing the string in the form $y = a\sin\left(\frac{\pi x}{L}\right)$ from which it is released at a time $t = 0$. Find the displacement $y(x, t)$ of any point at a distance x from one end at time t.

BSc Engg(M) , 2nd Sem. 27 October 2018 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester, A.Y. 2017-2018

Time : 3 hours — Full Marks : 100

Course code:MCE 4241 **Title:Computer Programming and Application**

Programmable calculators are not allowed. Do not write anything on the question paper.

There are **8 (eight)** questions. Answer any **6 (six)** of them including number **8 (eight)**.

Figures in the right margin indicate marks.

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1. a) What are ASCII Values and ASCII Characters? Write a program to print the ASCII values of character starting from '0' up to '9'. (7)

   b) Write down code to print all prime numbers within the range of 0 to 100. (10)

2. a) What is recursion? Can recursive function do the work of a loop? (2)

   b) Write a program in C Program to calculate sum of numbers from 1 to 100 using recursion. (8)

   c) Write a program in C to find the Factorial of a number using recursion. (7)

3. a) Write down the output for the following code: (8)

```
#include <stdio.h>
#include <string.h>
int main ()
{ char str1[100] = "I am going to be a Mechanical Engineer ";
  char str2[100] = "From MCE department of IUT";
  char str3[100];
  int  len ;
  strcpy(str3, str1);
  printf("%s\n", str3 );
  strcat( str1, str2);
  printf("%s\n", str1 );
  len = strlen(str1);
  printf("strlen(str1) :  %d\n", len );
  return 0;
}
```

   b) Write a program that converts kilometer to mile. Use a function k_to_m() to perform the conversion. Call it with the number of kilometers and have it return the number of miles inside the main function. Take 1 mile = 1.61 kilometer. (9)

4. a) Write a program in C to sort the elements of array in ascending order using bubble sort algorithm. (8)

   b) Write a C programming code for binary search algorithm. (9)

5. a) Write a C program to find if a given year is a leap year or not. (6)

   b) Write a program which will take three integers as input print the maximum and minimum value among those three values. (6)

   c) Write down the output for the following code: (5)

```
#include <stdio.h>
void main()
```

```
{ int i,j,spc,rows=5,k,t=1;

spc=rows+4-1;
for(i=1;i<=rows;i++)
{
    for(k=spc;k>=1;k--)
      {
       printf(" ");
      }
        for(j=1;j<=i;j++)
        printf("%d ",t++);
      printf("\n");
 spc--;
 }
}
```

6. a) Write a program in C to print all permutations of a given string using pointers. (10)
   b) An electric power distribution company charges its domestic consumers as follows (7)

Consumption Units	Rate
0-200	Tk.0.50 per unit
201-400	Tk.100 plus Tk.0.65 per unit excess 200
401-600	Tk.230 plus Tk.0.80 per unit excess of 400.

Write a program in C that reads the customer number and power consumed and prints the amount to be paid by the customer.

7. a) Write a program which will take an integer n as input and print from 1 up to n in the following way: (8)

```
1
2 3
4 5 6
7 8 9 10
```

The output above is given for n = 10

   b) The semester final in IUT is almost at an end and so the IUTians are eagerly planning a tour but they are in a dilemma whether to go. Some of the constraints are money and how well would they perform in the exam. If someone has performed **very good** in the exam no matter how much money s/he has, s/he will visit **Cox's Bazar** even by borrowing money from her/his friends. But if someone has performed **good** and has at least **5000** BDT s/he will visit **Cox's Bazar**. Otherwise, if someone who performed **good** but has **less than 5000**, will visit places in **Dhaka**. Finally, if someone performed **bad**, then no matter how much money s/he has, s/he will **Stay Home** and prepare her/himself to ace the next semester. (9)

Now, you have to write a program where it will take an integer & a string as input and based on the scenario described above print whether the student will visit Cox's Bazar/ Dhaka / Stay Home.

The question below must be answered

8 a) Write a code to print Fibonacci numbers within the range of 0 to 10000. (8)
i.e : 0 1 1 2 3 5 8 13 ... ...

   b) Write code using recursion function to print the summation of natural number 98 (7)

B.Sc. Engg. (M)/HDME, 4th Sem. 8 October 25, 2018

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Final Semester Examination — Summer Semester, A. Y. 2017-2018
Course No.: MCE 4407 — Time: 3 Hours
Course Title: Instrumentation and Measurements — Full Marks: 150

There are 8 (Eight) questions. Answer any 6 (Six) questions.

Marks in the margin indicate full marks. Programmable calculators are not allowed.
Do not write on this question paper.

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1. a) What are the main factors governing the choice of a measuring instrument for a given application? Name and discuss three application areas for measurement systems. 13

   b) What are the common errors found in a bourdon tube pressure gauge? Describe the steps and equipment needed to calibrate such an instrument. 12

2. a) A load cell is calibrated in an environment at a temperature of 21°C and has the following deflection/load characteristic: 13

Load (kg)	0	50	100	150	200
Deflection (mm)	0.0	1.0	2.0	3.0	4.0

When used in an environment at 35°C, its characteristic changes to the following:

Load (kg)	0	50	100	150	200
Deflection (mm)	0.2	1.3	2.4	3.5	4.6

i) Determine the sensitivity at 21°C and 35°C.
ii) Calculate the total zero drift and sensitivity drift at 35°C.
iii) Hence determine the zero drift and sensitivity drift coefficients (in units of μm/°C and (μm per kg)/ (°C).

   b) Briefly describe the following static characteristics of an instruments: 12
i) Accuracy and Inaccuracy, ii) Tolerance, iii) Linearity, iv) Threshold

3. a) Draw the schematic diagram of a Pyrometry measurement arrangement and explain its working principle. 13

   b) Explain what each of the following are in relation to thermocouples: 12
i) Law of interior temperature,
ii) Law of inserted material,
iii) Law of intermediate metals, and
iv) Law of intermediate temperature.

4. a) A humidity sensor (or hygrometer) senses, measures and reports the relative humidity in the air. Relative humidity is the ratio of actual moisture in the air to the highest amount of moisture that can be held at that air temperature. How actually the humidity sensor works to measure the relative humidity? Explain with necessary diagram. 13

b) How can you measure linear and angular displacement by resistive sensor? Write down the characteristics of resistive sensor. 12

5. a) To measure the pressure with the help of a Wheatstone bridge circuit, which sensor will you choose and why? Draw the measuring arrangement and explain briefly. 13
   b) What is the working range of Pirani thermal-conductivity gauge? Briefly explain its working principle. 12

6. a) Draw the circuit diagram of an inverting amplifier and derive the general expression of its output voltage. 13
   b) For 3.8 V, calculate is the digital output by using a Successive-Approximation ADC method? Also calculate the error. (8-bit A/D with range 0V – 5V) 12

7. a) What is the purpose of a data acquisition system? Draw the signal flow chart of a data acquisition system and explain its components. 13
   b) Write short note on the following sensor in terms of robotics application: 12
      i) Smoke Detectors
      ii) Color sensor

8. a) Write down the working principle of thermal flow meter. What is the major constrain of this flow meter and why? 13
   b) How fluid level can be measured by nuclear sensor? Write down its advantages and disadvantages. 12

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester, A.Y. 2017-2018
Course Code: MCE 4413 — Time : 3.0 hours
Course Title: Heat Transfer: Conduction and Radiation — Full Marks : 150

There are **Eight (08)** Questions. Answer any **Six (06)** of them.
Do not write on the question paper. Marks in the Margin indicate the full marks.

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1 a) On a hot summer day, a student turns his fan on when he leaves his room in the morning. When he returns in the evening, will his room be warmer or cooler than the neighboring rooms? Why? Assume all the doors and windows are kept closed. **03**

b) How do the thermal conductivity of gases and liquids vary with temperature? Consider an alloy of two metals whose thermal conductivities are k_1 and k_2. Will the thermal conductivity of the alloy be less than k_1, greater than k_2, or between k_1 and k_2? **04**

c) A 0.2-L glass of water at 20°C is to be cooled with ice to 5°C (**Fig. 01**). Determine how much ice needs to be added to the water, in grams, if the ice is at 0°C. Also, determine how much water would be needed if the cooling is to be done with cold water at 0°C. The melting temperature and the heat of fusion of ice at atmospheric pressure are 0°C and 333.7 kJ/kg, respectively, and the density of water is 1 kg/L. **08**

Figure: 01

d) A hair dryer is basically a duct in which a few layers of electric resistors are placed (**Fig. 02**). A small fan pulls the air in and forces it to flow over the resistors where it is heated. Air enters a 1200-W hair dryer at 100 kPa and 22°C, and leaves at 47°C. The cross-sectional area of the hair dryer at the exit is 60 cm2. Neglecting the power consumed by the fan and the heat losses through the walls of the hair dryer, determine (*a*) the volume flow rate of air at the inlet and (*b*) the velocity of the air at the exit. **10**

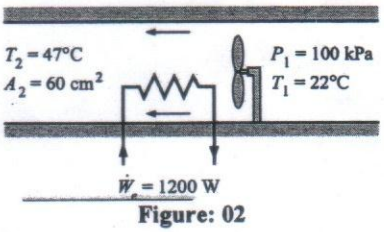


Figure: 02

2. a) Consider a 20-cm-thick large concrete plane wall (k=0.77 W/m.°C) subjected to convection on both sides with T_1=27°C and h_1=5 W/m^2.°C on the inside, and T_2=8°C and h_2=12 W/m^2.°C on the outside. Assuming constant thermal conductivity with no heat generation and negligible radiation, (*a*) express the differential equations and the boundary conditions for steady one-dimensional heat conduction through the wall, (*b*) obtain a relation for the variation of temperature in the wall by solving the differential equation, and (*c*) evaluate the temperatures at the inner and outer surfaces of the wall. **12**

b) Consider a homogeneous spherical piece of radioactive material (**Fig. 03**) of radius r_0 = 0.04 m that is generating heat at a constant rate of g=4 x 107 W/m^3. The heat generated is dissipated to the environment steadily. The outer surface of the sphere is maintained at a uniform temperature of 80°C and the thermal conductivity of the sphere is k =15 W/m.°C. Assuming steady one-dimensional heat transfer, (*a*) express the differential equation and the boundary conditions for heat conduction through the sphere, (*b*) obtain a relation for the variation of temperature in the sphere by solving the differential equation, and (*c*) determine the temperature at the center of the sphere. **13**

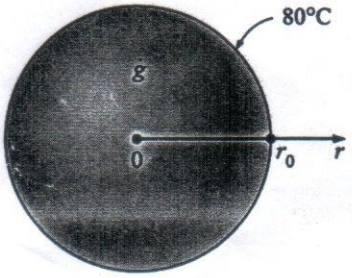


Figure: 03

3. a) Starting with an energy balance on a cylindrical shell volume element, derive the steady one-dimensional heat conduction equation for a long cylinder with constant thermal conductivity in which heat is generated at a rate of g. **10**

b) Consider a hot dog being cooked in boiling water in a pan. Would you model the heat transfer to the hot dog as one-, two-, or three-dimensional? Would the heat transfer be steady or transient? Also, which coordinate system would you use to solve this problem, and where would you place the origin? Explain. **05**

c) In a food processing facility, a spherical container (**Fig. 04**) of inner radius r_1=40 cm, outer radius r_2=41 cm, and thermal conductivity k =1.5 W/m.°C is used to store hot water and to keep it at 100°C at all times. To accomplish this, the outer surface of the container is wrapped with a 500-W electric strip heater and then insulated. The temperature of the inner surface of the container is observed to be nearly 100°C at all times. Assuming 10 percent of the heat generated in the heater is lost through the insulation; (*a*) express the differential equation and the boundary conditions for steady one-dimensional heat conduction through the container, (*b*) obtain a relation for the variation of temperature in the container material by solving the differential equation, and (*c*) evaluate the outer surface temperature of the container. Also determine how much water at 100°C this tank can supply steadily if the cold water enters at 20°C. **10**

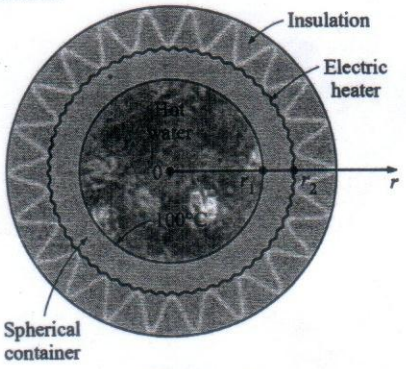


Figure: 04

4. a) How does the thermal resistance network associated with a single-layer plane wall differ from the one associated with a five-layer composite wall? **05**

b) Consider two cold canned drinks, one wrapped in a blanket and the other placed on a table in the same room. Which drink will warm up faster? **05**

c) Consider a 5-m-high, 8-m-long, and 0.22-m-thick wall whose representative cross section is as given in **Fig. 05**. The thermal conductivities of various materials used, in W/m.°C, are k_A=k_F=2, k_B=8, k_C=20, k_D=15, and k_E=35. The left and right surfaces of the wall are maintained at uniform temperatures of 300°C and 100°C, respectively. Assuming heat transfer through the wall to be one-dimensional, determine (*a*) the rate of heat transfer through the wall; (*b*) the temperature at the point where the sections B, D, and E meet; and (*c*) the temperature drop across the section F. Disregard any contact resistances at the interfaces. **15**

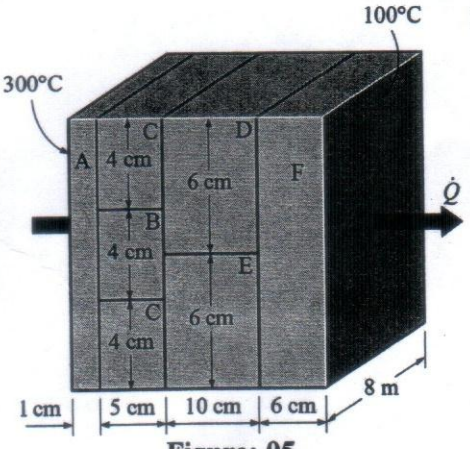


Figure: 05

5. a) i. What is the critical radius of insulation? How is it defined for a cylindrical layer? **10**

ii. A pipe is insulated such that the outer radius of the insulation is less than the critical radius. Now the insulation is taken off. Will the rate of heat transfer from the pipe increase or decrease for the same pipe surface temperature?

iii. A pipe is insulated to reduce the heat loss from it. However, measurements indicate that the rate of heat loss has increased instead of decreasing. Can the measurements be right?

iv. Consider a pipe at a constant temperature whose radius is greater than the critical radius of insulation. Someone claims that the rate of heat loss from the pipe has increased when some insulation is added to the pipe. Is this claim valid?

v. Consider an insulated pipe exposed to the atmosphere. Will the critical radius of insulation be greater on calm days or on windy days? Why?

b) Two 3-m-long and 0.4-cm-thick cast iron (k=52 W/m.°C) steam pipes of outer diameter 10 cm are connected to each other through two 1-cm-thick flanges of outer diameter 20 cm as shown in **Fig. 06**. The steam flows inside the pipe at an average temperature of 200°C with a heat transfer coefficient of 180 W/m^2.°C. The outer surface of the pipe is exposed to an ambient at 12°C, with a heat transfer coefficient of 25 W/m^2.°C. (a) Disregarding the flanges, determine the average outer surface temperature of the pipe. (b) Using this temperature for the base of the flange and treating the flanges as the fins, determine the fin efficiency and the rate of heat transfer from the flanges. (c) What length of pipe is the flange section equivalent to for heat transfer purposes? **15**

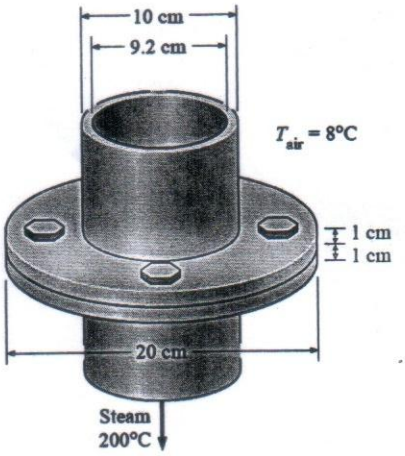


Figure: 06

6. a) Obtain a relation for the time required for a lumped system to reach the average temperature (T_i - T_a), where T_i is the initial temperature and T_a is the temperature of the environment. **05**

b) **10**

i. What is lumped system analysis? When is it applicable?

ii. Consider heat transfer between two identical hot solid bodies and the air surrounding them. The first solid is being cooled by a fan while the second one is allowed to cool naturally.

iii. For which solid is the lumped system analysis more likely to be applicable? Why?

iv. Consider heat transfer between two identical hot solid bodies and their environments. The first solid is dropped in a large container filled with water, while the second one is allowed to cool naturally in the air. For which solid is the lumped system analysis more likely to be applicable? Why?

v. What is the physical significance of the Biot number? Is the Biot number more likely to be larger for highly conducting solids or poorly conducting ones?

c) We often cut a watermelon in half and put it into the freezer to cool it quickly. But usually we forget to check on it and end up having a watermelon with a frozen layer on the top. To avoid this potential problem a person wants to set the timer such that it will go off when the temperature of the exposed surface of the watermelon drops to 3°C. Consider a 30-cm-diameter spherical watermelon that is cut into two equal parts and put into a freezer at -12°C (**Fig. 07**). Initially, the entire watermelon is at a uniform temperature of 25°C, and the heat transfer coefficient on the surfaces is 30 W/m^2.°C. Assuming the watermelon to have the properties of water, determine how long it will take for the center of the exposed cut surfaces of the watermelon to drop to 3°C. **10**

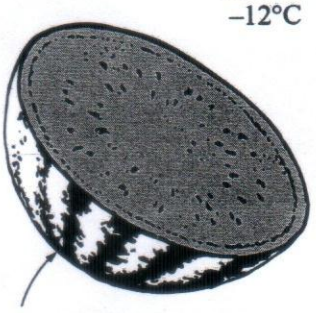


Figure: 07

7 a) How do numerical solution methods differ from analytical ones? What are the advantages and disadvantages of numerical and analytical methods? **05**

b) Two engineers are to solve an actual heat transfer problem in a manufacturing facility. Engineer A makes the necessary simplifying assumptions and solves the problem analytically, while engineer B solves it numerically using a powerful software package. Engineer A claims he solved the problem exactly and thus his results are better, while engineer B claims that he used a more realistic model and thus his results are better. To resolve the dispute, you are asked to solve the problem experimentally in a lab. Which engineer do you think the experiments will prove right? Explain. **05**

c) Consider an aluminum alloy fin (k = 175 W/m·°C) of triangular cross section (**Fig. 08**) with length L = 5.6 cm, base thickness b = 1.5 cm, and very large width w in the direction normal to the plane of paper, as shown in Figure. The base of the fin is maintained at a temperature of T_0 = 223°C. The fin is losing heat to the surrounding medium at T_∞= 26.5°C with a heat transfer coefficient of h =17 W/m^2.°C. Using the finite difference method with six equally spaced nodes along the fin in the x-direction, determine (a) the temperatures at the nodes, (b) the rate of heat transfer from the fin for w = 1.15 m, and (c) the fin efficiency. **15**

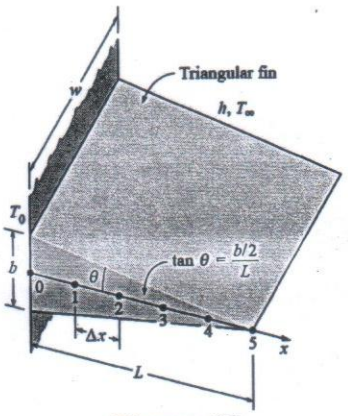


Figure: 08

8. a) i. By what properties is an electromagnetic wave characterized? How are these properties related to each other? **10**

ii. Why did we define the blackbody radiation function? What does it represent? For what is it used?

ii. What does a solid angle represent, and how does it differ from a plane angle? What is the value of a solid angle associated with a sphere?

v. Define the properties emissivity and absorptivity. When are these two properties equal to each other?

v. What are the summation rule and the superposition rule for view factors? Consider an enclosure consisting of five surfaces. How many view factors does this geometry involve? How many of these view factors can be determined by the application of the reciprocity and summation rules?

b) Consider a 20-cm-diameter spherical ball at 800 K suspended in air as shown in **Fig. 09**. Assuming the ball closely approximates a blackbody; determine (a) the total blackbody emissive power, (b) the total amount of radiation emitted by the ball in 5 min, and (c) the spectral blackbody emissive power at a wavelength of 3 μm. **08**

c) The emissivity of a surface coated with aluminum oxide can be approximated to be 0.2 for radiation at wavelengths less than 5 μm and 0.9 for radiation at wavelengths greater than 5 μm. Determine the average emissivity of this surface at (a) 5800 K and (b) 300 K. What can you say about the absorptivity of this surface for radiation coming from sources at 5800 K and 300 K? **07**

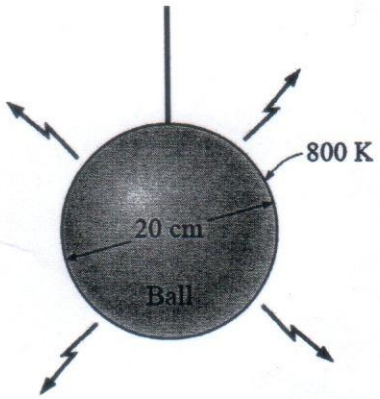
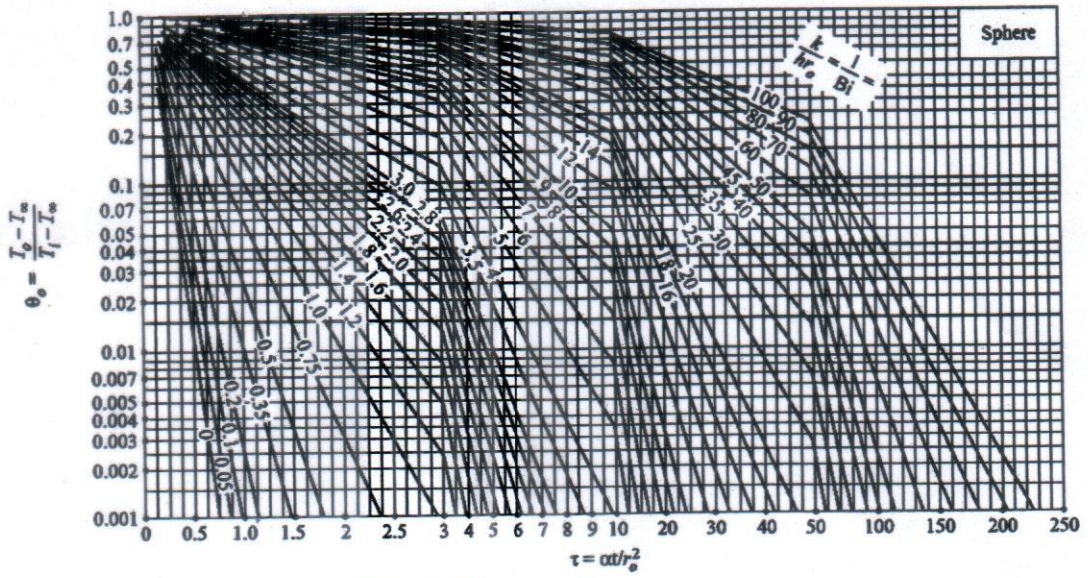
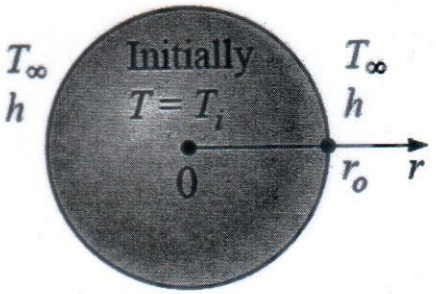
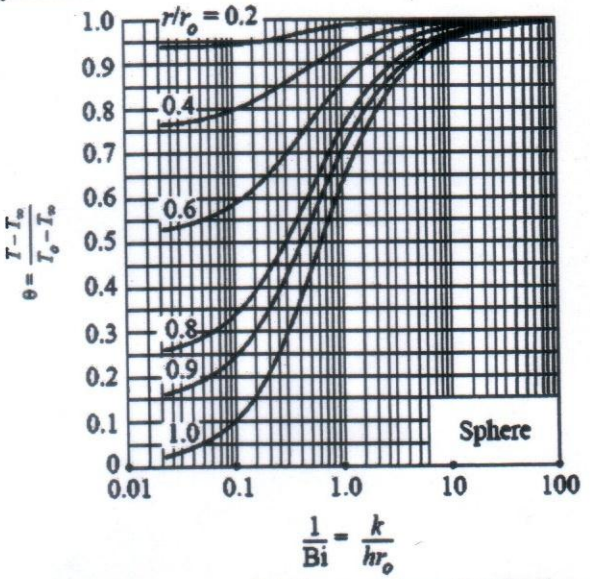


Figure: 09

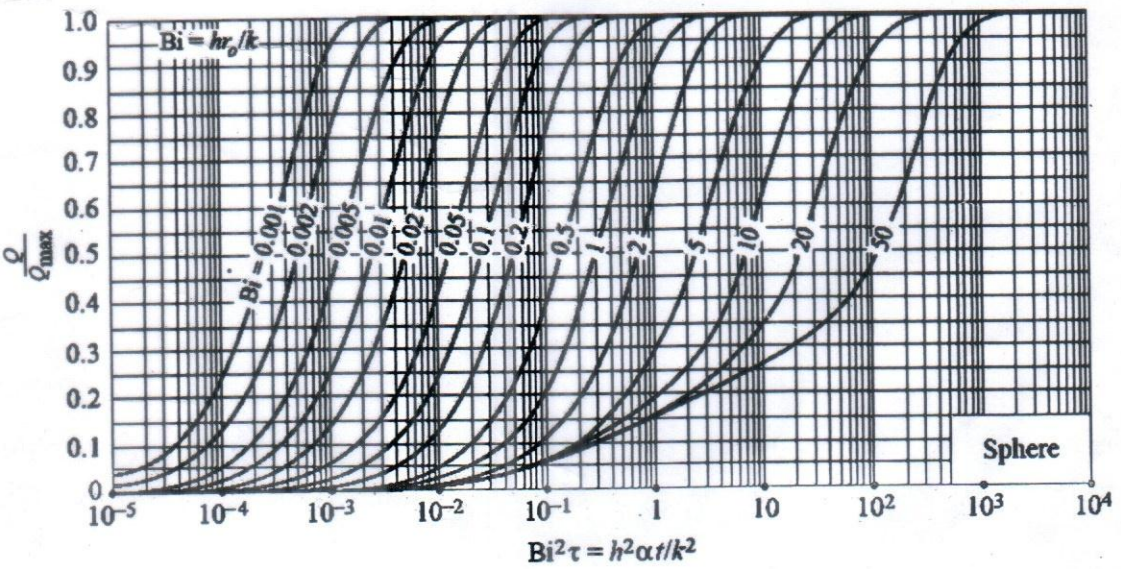


(a). Midpoint Temperature





(b) Temperature distribution



(c) Heat transfer

Figure: Transient temperature and heat transfer charts for a sphere of radius r_o initially at a uniform temperature T_i subjected to

15

PROGRAMME : B.Sc.Engg.(M)/4th Sem. 01 November 2018
HDME/ 4th Sem.

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

THE ORGANIZATION OF THE ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

SEMESTER FINAL EXAMINATION SUMMER SEMESTER: 2017-2018
COURSE NO. MCE 4425 TIME: 3 HRS
COURSE TITLE: Metallurgy FULL MARKS: 100

There are EIGHT Questions. Answer any SIX Questions.
Marks in the Margin indicate full marks.
(Graph paper to be supplied)

1. Answer any **three** of the following: ($5^5/_9$x3)
   (a) Draw the neat sketches of the three common types of space lattice. Calculate the number of atoms per unit cell in each of them.
   (b) Calculate the atomic packing factor for a body centered cubic crystal.
   (c) Sketch the following crystallographic planes and directions for the cubic system: (i) (111), (ii) (011), (iii) (222), (iv) [111], (v) [110], (vi) [100].
   (d) Distinguish between (i) hardness and toughness and (ii) creep and fatigue

2. (a) Distinguish between acid Bessemer converter and describe basic Bessmer converter processes of steel making. (03)
   (b) Draw a neat sketch of a Bessemer converter. Describe briefly how steel is produced by the basic Bessemer converter process of steel making. (10)
   (c) Why and how are deoxidation and recarburization carried out at the end of the steel making process? ($3^2/_3$)

3. (a) Distinguish between substitutional solid solution and interstitial solid solution. (04)
   (b) Bismuth (melting point 520 ^{0}F) and cadmium (melting point 610 ^{0}F) are assumed to be completely soluble in the liquid state and completely insoluble in the solid state. They form a eutectic at 290 ^{0}F containing 40 percent cadmium.
      (i) Draw the equilibrium diagram to scale on a piece of graph paper and label all points, lines, and areas. ($12^2/_3$)
      (ii) For an alloy containing 70 percent cadmium
         (i) Give the temperature of initial solidification;
         (ii) Give the temperature of final solidification;
         (iii) Give the chemical composition and relative amounts of the phases present at 100 ^{0}F below (1);
         (iv) Draw the microstructure at room temperature;
         () Draw the cooling curve.

4. (a) Draw the iron and iron carbide thermal equilibrium diagram labeling all points, lines and phase fields. Define austenite, ferrite and pearlite. ($12^2/_3$)

(b) Mention the effect of carbon content on the mechanical properties of hot rolled plain carbon steel. (04)

5. (a) What is heat treatment? What is the purpose of heat treatment? (03)
   (b) Distinguish between annealing and normalizing. Mention at least four advantages of each. ($9^2/_3$)
   (c) Draw the microstructure of mild steel rod both in the annealed and normalized conditions. Indicate which steel is stronger and why? (04)

6. (a) What is martensite? Give an outline of the formation of martensite. What is meant by the terms M_s and M_f ? Mention at least four important quenching media. (08)
   (b) What is tempering? What is the purpose of tempering? Mention the effect of tempering temperature on the hardness, toughness and residual stress of a quenched high carbon steel part. ($8^2/_3$)

7. (a) Define term 'alloy steel'? State the purpose of making alloy steel. (04)
   (b) What is stainless steel? Mention the main groups of stainless steel? Give their composition, properties and application. ($12^2/_3$)

8. (a) Draw a neat sketch of the most commonly used furnace for the production of cast iron, showing its salient parts. (05)
   (b) Classify steel and cast iron. (03)
   (c) Distinguish between (i) white cast iron and gray cast iron; (ii) malleable cast iron and ductile cast iron. Mention at least three applications of each. ($8^2/_3$)

DTE 2nd Sem **24 October 2018**

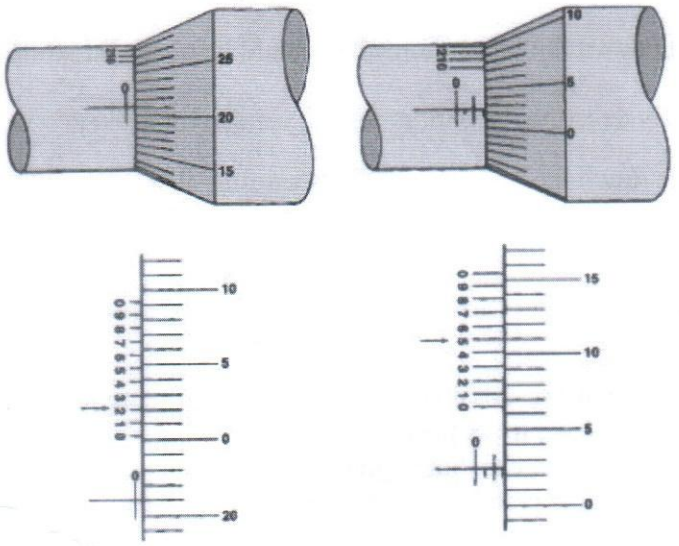
ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester : A.Y. 2017-2018
Course Code: MCE 4493 — Time : 3 Hours
Course Title : Automotive Maintenance Engineering — Full Marks : 150

There are 8 (Eight) Questions. Answer any 6 (Six) Questions.
Marks in the Margin indicate full marks. Don't write on this question paper.

1. a) Write different types of Punches with uses. 10

b) In a micrometer, the thimble rotates over the sleeve on a screw that has 40 threads per inch. Every revolution of the thimble moves the spindle 0.025 in. The thimble is graduated into 25 equally spaced lines. From figure 1, find the reading. 15



(i) (ii)

Figure 1: Micrometer

2. a) Describe the following measuring instruments in brief - 15
i. Inside and outside calipers
ii. Dial indicator
iii. Piston ring expander
iv. Feeler gauges
v. Vacuum gauge

b) Briefly describe the steps for performing Basic Tune-Ups. 10

3. a) Categorize the different troubles and repairs of engine parts with explanation. 08

b) Describe the troubles and repairs of "piston and piston rings". 08

c) Write a short note on "valve service". 09

4. a) Explain the flushing of Engine Cooling System with necessary diagrams. 10

   b) Explain the following tests in engine cooling system- 15
      i. Cooling system pressure test
      ii. Combustion leak test
      iii. Thermostat test

5. a) How to perform the antifreeze servicing? 06

   b) Explain the basic four lubricating system problems. 12

   c) How to replace the filter elements of the two known filters in lubricating system? 07

6. a) Write down the precautions that should be observed while charging a battery. 10

   b) Briefly describe the battery testing using hydrometer? 08

   c) Write down the important notes regarding disconnecting the battery. 07

7. a) Describe the procedure to perform the "Current Draw Test" for the starting system. 10

   b) Write down the possible causes of the following starting problems with actions needed to solve these problems – 15
      i. Starter spins, but engine will not crank
      ii. Engine cranks too slowly to start
      iii. Starter keeps running
      iv. Engine cranks too slowly to start
      v. Engine will not crank

8. a) Write down the procedure that should be followed when cleaning spark plugs. 07

   b) Write down the procedure of performing a spark test with figures if needed. 08

   c) Write a short note on "spark plug installation". 10

B.Sc.Engg. (M)/ 4th Sem. /
HDME /4th Sem.
/B.Sc.TE(2 Yr-Prog.)/2nd Sem.

October 23, 2018

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

FINAL SEMESTER EXAMINATION
COURSE NO: MCE 4403/MCE 4695
COURSE TITLE: MECHANICS OF MATERIALS

SUMMER SEMESTER: 2017-2018
TIME : 3.00 HRS
FULL MARKS : 200

There are **EIGHT** Questions. Answer any **SIX** Questions.
Figures in the Right Margin indicate full marks. Assume data if missing or necessary.
Programmable calculators are not allowed. Do not write on this question paper.

1. A cast-iron bracket subjected to bending has a cross-section of *I*-shaped with unequal flanges shown in Fig.1. If the compressive stress in top flange is not to exceed 17.5 MPa, what is the bending moment, the section can take? If the section is subjected to a shear force of 100 kN, draw the shear stress distribution over the depth of the section. (33.33)

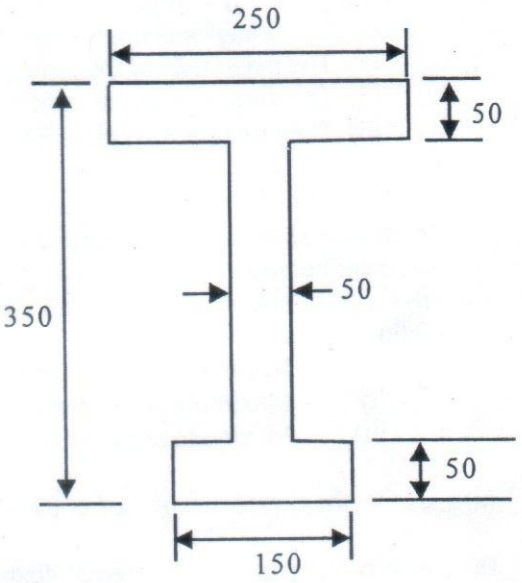


Fig.1 All dimensions are in mm

2. (a) Derive the expression of critical load or crippling load of a column with one end fixed and the other free. (17)

(b) A T-section 160 mm×140 mm×30 mm is used as a strut of 5 m long with one end fixed and the other end free shown in Fig.2. Determine the crippling load, if Young's modulus for the material be 200 GPa. (16.33)

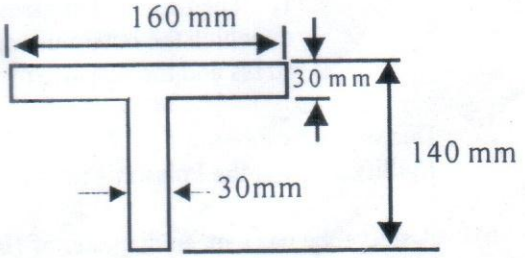


Fig.2

3. (a) Derive the expressions of slope and deflection of a beam using Mohr's Area Moment Method. (13.33)

(b) Determine the deflection at a point 1.5 m from the left-hand end of the beam loaded as shown in Fig.3. Assume EI=0.75 MNm^2. (20)

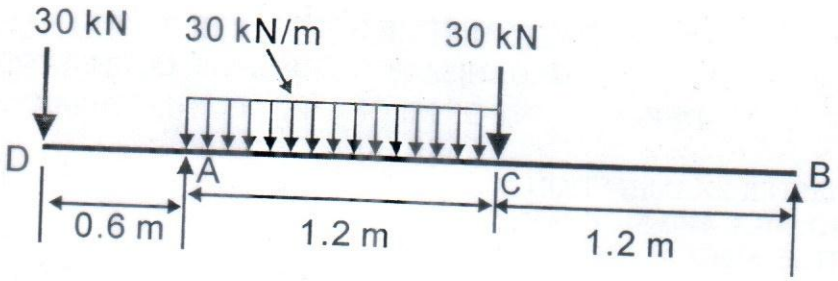


Fig.3

4. A rectangular rosette of strain gauges on the surface of a material under stress recorded the following readings of strain: Gauge A: $+450\times10^{-6}$; Gauge B, at 45^0 to A: $+200\times10^{-6}$; and Gauge C, at 90^0 to A: -200×10^{-6}, the angles being counterclockwise from A. Determine: (33.33)
   i) The magnitude of the principal strains.
   ii) The directions of the principal strain axes.
   iii) The principal stresses if E=200 GPa and v=0.3.

5. A circular shaft, 100 mm diameter is subjected to combined bending moment and torque, the bending moment being 3 times the torque. If the direct tension yield point of the material is 300 MPa and the factor of safety on yield is to be 4, calculate the allowable twisting moment by considering the three following theories of failure: (33.33)
   i) Maximum principal stress theory
   ii) Maximum shear stress theory
   iii) Maximum shear strain energy.

6. (a) Derive the expression of the hoop and longitudinal stresses for the thin-walled cylinders. (15)

   (b) A thick cylinder has an internal diameter of 75 mm and an external diameter of 125 mm. The ends are closed and it carries an internal pressure of 60 MPa. Neglecting end effects, calculate the hoop stress and radial stress at radii of 37.5 mm, 50 mm and 62.5 mm. What is the value of the longitudinal stress in the cylinder? (18.33)

7. A material is subjected to a horizontal tensile stress of 90 MPa and a vertical tensile stress of 120 MPa, together with shear stresses of 75 MPa, those on the 120 MPa planes being counter clockwise in effect. Determine: (33.33)
   i) The principal stresses; ii) the maximum shear stress; iii) the directions of the planes on which the maximum principal stresses and the maximum shear stress act; iv) the shear stress and the normal stress at the plane 30^0 from the plane of maximum principal stress.

8. a) Derive the expression $E = 2G(1 + \nu)$ where E is the modulus of elasticity, G is the modulus of rigidity and ν is the Poisson's ratio. (13)

   b) A steel tube has a mean diameter of 100 mm and a thickness of 3 mm. Calculate the torque which can be transmitted by the tube with a factor of safety of 2.5 if the criterion of failure is i) maximum shear stress; ii) maximum total strain energy per unit volume; iii) maximum shear strain energy per unit volume. The elastic limit of the steel in tension is 250 MPa and Poisson's ratio ν is 0.28. (20.33)

BScEngg(M)/HDME/6thSem. 31 October 2018 (Morning)
BScTE/2nd Sem.

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester, A.Y. 2017-2018
Course Code: MCE 4609/MCE 4693 — Time : 3 hours
Course Title: Machine Design I — Full Marks : 100

There are **8 (eight)** Questions. Answer any **6 (six)** of them.
Assume reasonable value for missing data

1.(a) A brittle material has the properties S_{ut} =30 kpsi and S_{uc} =90 kpsi, (a) find the factors of safety using the BCM and MM theories (b) plot the failure diagrams in the σ_A, σ_B plane to scale and locate the coordinates of the stress state, and (c) estimate the factors of safety from the two theories by graphical measurements along the load line. 11

σ_x=-10 kpsi, σ_y=-25 kpsi, τ_{xy}=-10 kpsi

(b) An AISI 1018 steel has a yield strength, Sy =295 MPa. Using the distortion-energy theory for the given state of plane stress, (a) determine the factor of safety, (b) plot the failure locus, the load line, and estimate the factor of safety by graphical measurement. 5⅔

σ_x= -80 MPa, σ_y=30 MPa, τ_{xy}=-10 Mpa

2. A column with one end fixed and the other free is to be made of AISI 1035 steel (E=72GPa, G=35 GPa). The column cross-sectional area is to be 600 mm^2 and its length is 2.5 m. 16⅔
Find the critical buckling load for the following cross-sections:
a) A solid round bar
b) A solid square bar

3. The shaft shown in the Figure 1 is machined from AISI 1040 CD steel. The shaft rotates at 1600 rpm and is supported in rolling bearings at A and B. The applied forces are F_1 = 2500 lbf and F_2 = 1000 lbf. Determine the minimum fatigue factor of safety based on achieving infinite life. If infinite life is not predicted, estimate the number of cycles to failure. Also check for yielding. 16⅔

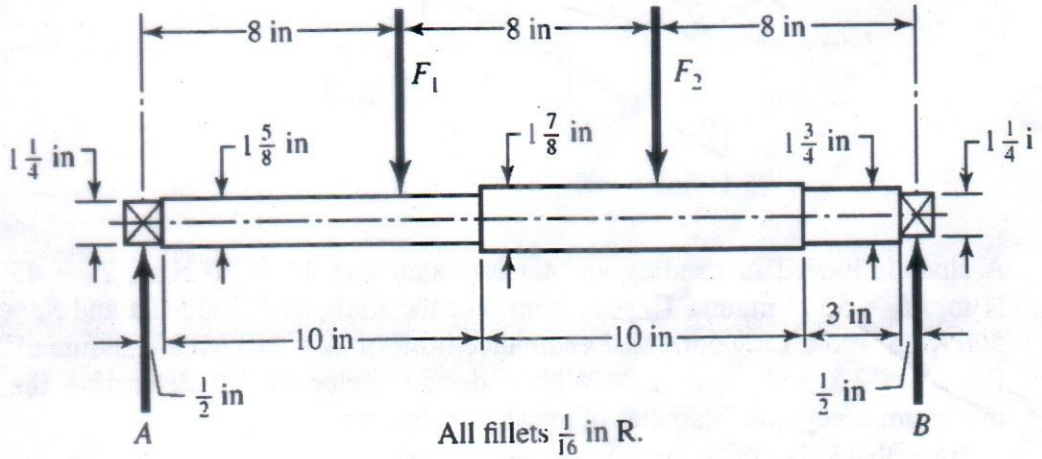
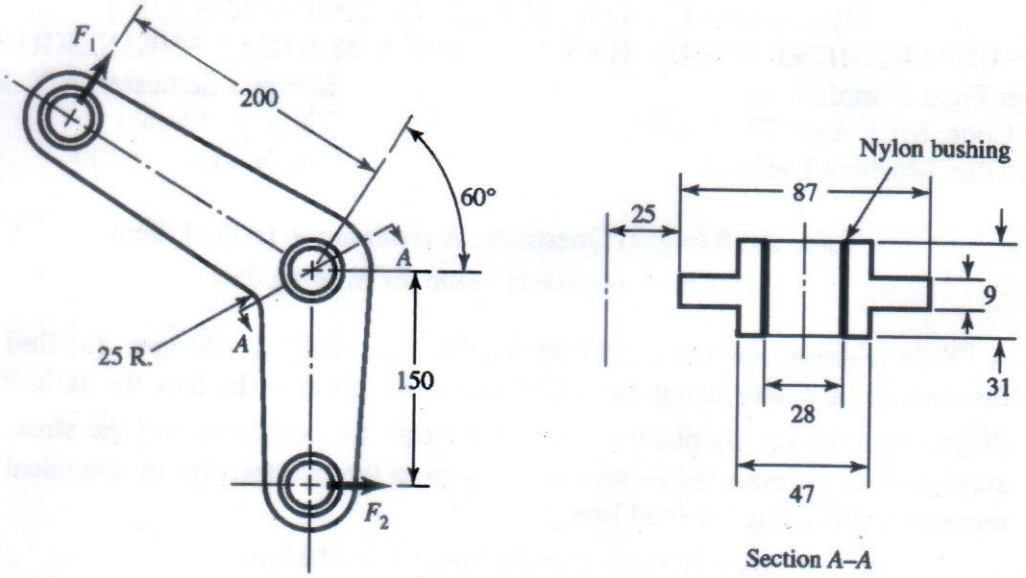


Fig. 1

4. The cast-iron bell-crank lever depicted in the Figure 2 is acted upon by forces F_1 of 2.4 kN and F_2 of 3.2 kN. The section A–A at the central pivot has a curved inner surface with a radius of r_i = 25 mm. Estimate the stresses at the inner and outer surfaces of the curved portion of the lever. 16⅔



Dimensions in mm

Fig.2

5. Figure 3 shows a shaft mounted in bearings at A and D and having pulleys at B and C. The forces shown acting on the pulley surfaces represent the belt tensions. The shaft is to be made of AISI 1035 CD steel. Using a conservative failure theory with a design factor of 2, determine the minimum shaft diameter to avoid yielding. 16⅔

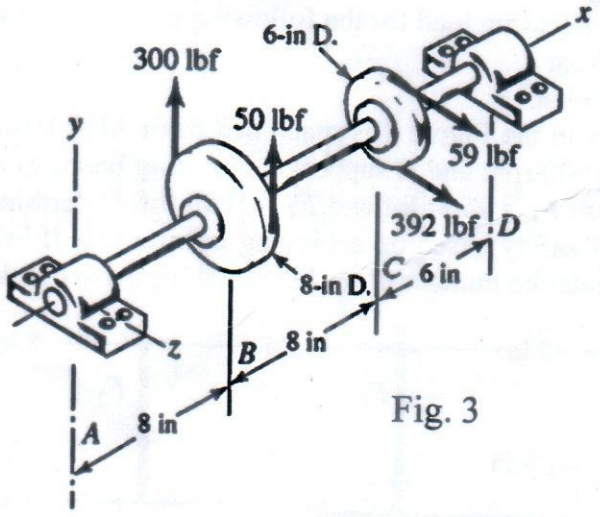


Fig. 3

6. A shaft is loaded in bending and torsion such that M_a = 70 N·m, T_a = 45 N·m, M_m = 55 N·m, and T_m = 35 N·m. For the shaft, S_u = 700 MPa and S_y = 560 MPa, and a fully corrected endurance limit of S_e = 210 MPa is assumed. Let K_f = 2.2 and K_{fs} = 1.8. With a design factor of 2.0 determine the minimum acceptable diameter of the shaft using the 16⅔

(a) DE-Gerber criterion.
(b) DE-ASME Elliptic criterion.
(c) DE-Soderberg criterion.
(d) DE-Goodman criterion

7. A gear-reduction unit uses the countershaft depicted in the figure 4. Find the two bearing reactions. The bearings are to be angular-contact ball bearings, having a desired life of 50kh when used at 300 rev/min. Use 1.2 for the application factor and a reliability goal for the bearing pair of 0.96, Select the bearings from Table 11–2. 16⅔

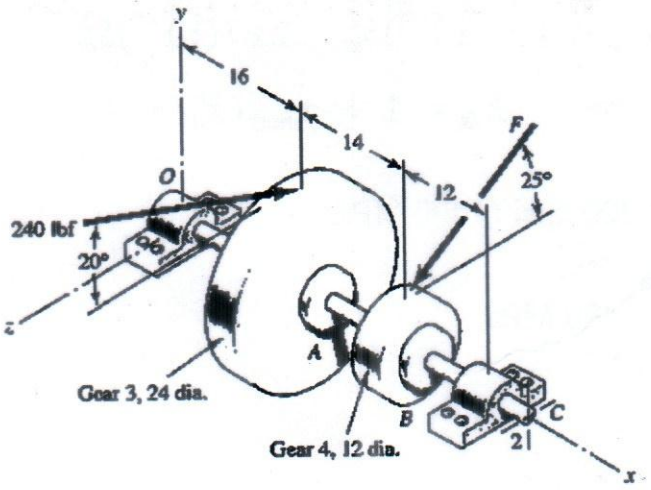


Fig. 4

8. The cantilevered bar in the figure 5 is made from a ductile material and is loaded with F_y = 250 lbf and $F_x = F_z = 0$.Determinethe minimum factor of safety for fatigue at point A, based on infinite life, using the modified Goodman criterion. If the life is not infinite, estimate the number of cycles. The force F is applied as a repeated load. The material is AISI 1018 CD steel. 16⅔

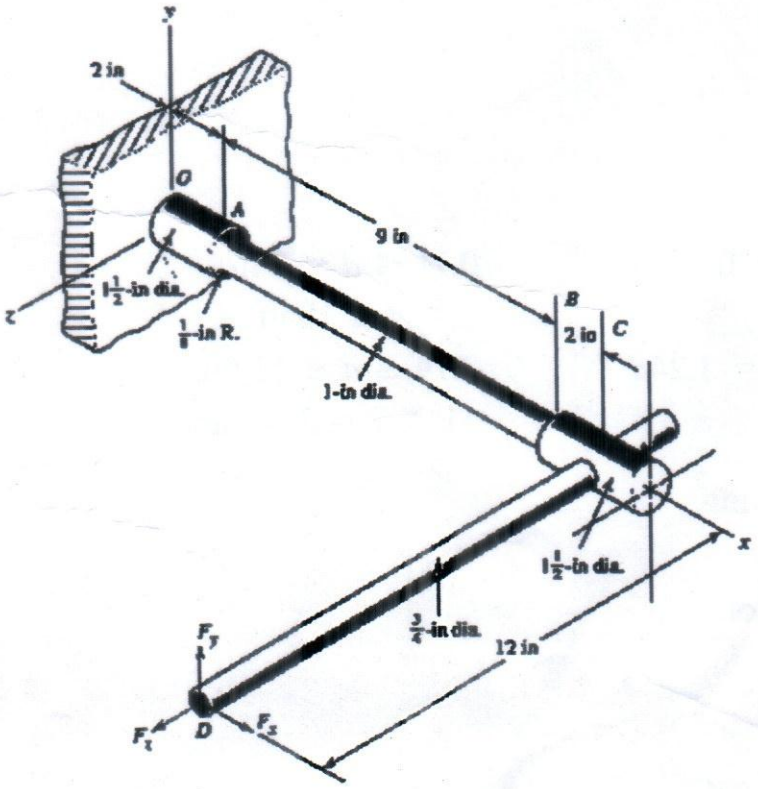


Fig. 5

Equations for shaft design:

notch sensitivity equation $$q = \frac{1}{1 + \frac{\sqrt{a}}{\sqrt{r}}}$$

$$\sqrt{a} = 0.246 - 3.08(10^{-3})S_{ut} + 1.51(10^{-5})S_{ut}^2 - 2.67(10^{-8})S_{ut}^3$$

$$K_f = 1 + q(K_t - 1) \qquad \text{or} \qquad K_{fs} = 1 + q_{\text{shear}}(K_{ts} - 1)$$

$$S'_e = \begin{cases} 0.5S_{ut} & S_{ut} \le 200 \text{ kpsi (1400 MPa)} \\ 100 \text{ kpsi} & S_{ut} > \text{kpsi} \\ 700 \text{ MPa} & S_{ut} > 1400 \text{ MPa} \end{cases}$$

$$a = \frac{(fS_{ut})^2}{S_e}$$

$$b = -\frac{1}{3}\log\left(\frac{fS_{ut}}{S_e}\right)$$

$$N = \left(\frac{\sigma_{\text{rev}}}{a}\right)^{1/b}$$

$$S_e = k_a k_b k_c k_d k_e k_f S'_e$$

$$k_a = aS_{ut}^b$$

$$k_b = \begin{cases} (d/0.3)^{-0.107} = 0.879d^{-0.107} & 0.11 \le d \le 2 \text{ in} \\ 0.91d^{-0.157} & 2 < d \le 10 \text{ in} \\ (d/7.62)^{-0.107} = 1.24d^{-0.107} & 2.79 \le d \le 51 \text{ mm} \\ 1.51d^{-0.157} & 51 < d \le 254 \text{ mm} \end{cases}$$

$$k_c = \begin{cases} 1 & \text{bending} \\ 0.85 & \text{axial} \\ 0.59 & \text{torsion} \end{cases}$$

DE-Goodman

$$\frac{1}{n} = \frac{16}{\pi d^3}\left\{\frac{1}{S_e}[4(K_f M_a)^2 + 3(K_{fs} T_a)^2]^{1/2} + \frac{1}{S_{ut}}[4(K_f M_m)^2 + 3(K_{fs} T_m)^2]^{1/2}\right\}$$

$$d = \left(\frac{16n}{\pi}\left\{\frac{1}{S_e}[4(K_f M_a)^2 + 3(K_{fs} T_a)^2]^{1/2} + \frac{1}{S_{ut}}[4(K_f M_m)^2 + 3(K_{fs} T_m)^2]^{1/2}\right\}\right)^{1/3}$$

DE-Gerber

$$\frac{1}{n} = \frac{8A}{\pi d^3 S_e}\left\{1 + \left[1 + \left(\frac{2BS_e}{AS_{ut}}\right)^2\right]^{1/2}\right\}$$

$$d = \left(\frac{8nA}{\pi S_e}\left\{1 + \left[1 + \left(\frac{2BS_e}{AS_{ut}}\right)^2\right]^{1/2}\right\}\right)^{1/3}$$

where

$$A = \sqrt{4(K_f M_a)^2 + 3(K_{fs} T_a)^2}$$

$$B = \sqrt{4(K_f M_m)^2 + 3(K_{fs} T_m)^2}$$

DE-ASME Elliptic

$$\frac{1}{n} = \frac{16}{\pi d^3}\left[4\left(\frac{K_f M_a}{S_e}\right)^2 + 3\left(\frac{K_{fs} T_a}{S_e}\right)^2 + 4\left(\frac{K_f M_m}{S_y}\right)^2 + 3\left(\frac{K_{fs} T_m}{S_y}\right)^2\right]^{1/2}$$

$$d = \left\{\frac{16n}{\pi}\left[4\left(\frac{K_f M_a}{S_e}\right)^2 + 3\left(\frac{K_{fs} T_a}{S_e}\right)^2 + 4\left(\frac{K_f M_m}{S_y}\right)^2 + 3\left(\frac{K_{fs} T_m}{S_y}\right)^2\right]^{1/2}\right\}^{1/3}$$

DE-Soderberg

$$\frac{1}{n} = \frac{16}{\pi d^3}\left\{\frac{1}{S_e}[4(K_f M_a)^2 + 3(K_{fs} T_a)^2]^{1/2} + \frac{1}{S_y}[4(K_f M_m)^2 + 3(K_{fs} T_m)^2]^{1/2}\right\}$$

$$d = \left(\frac{16n}{\pi}\left\{\frac{1}{S_e}[4(K_f M_a)^2 + 3(K_{fs} T_a)^2]^{1/2} + \frac{1}{S_y}[4(K_f M_m)^2 + 3(K_{fs} T_m)^2]^{1/2}\right\}\right)^{1/3}$$

Formulas for curved beam:

$$r_n = \frac{A}{\int \frac{dA}{r}}$$

$$\sigma = \frac{My}{Ae(r_n - y)}$$

$$\sigma_i = \frac{Mc_i}{Aer_i} \qquad \sigma_o = -\frac{Mc_o}{Aer_o}$$

Formulas for Bearings:

$$C_{10} \approx a_f F_D \left[\frac{x_D}{x_0 + (\theta - x_0)(1 - R_D)^{1/b}} \right]^{1/a} \qquad R \geq 0.90$$

x_0 =0.02, (θ- x_0) =4.439, and b =1.483

Formulas for columns

$$P_{cr} = \frac{C\pi^2 EI}{l^2} \qquad \left(\frac{l}{k}\right)_1 = \left(\frac{2\pi^2 CE}{S_y}\right)^{1/2} \qquad \frac{P_{cr}}{A} = S_y - \left(\frac{S_y}{2\pi}\frac{l}{k}\right)^2 \frac{1}{CE}$$

$$\frac{P}{A} = \frac{S_{yc}}{1 + (ec/k^2)\sec[(l/2k)\sqrt{P/AE}]}$$

Table 4–2

End-Condition Constants for Euler Columns [to Be Used with Eq. (4–43)]

Column End Conditions	End-Condition Constant C		
	Theoretical Value	Conservative Value	Recommended Value*
Fixed-free	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
Rounded-rounded	1	1	1
Fixed-rounded	2	1	1.2
Fixed-fixed	4	1	1.2

*To be used only with liberal factors of safety when the column load is accurately known.

Table 6–2

Parameters for Marin Surface Modification Factor, Eq. (6–19)

Surface Finish	Factor a S_{ut}, kpsi	Factor a S_{ut}, MPa	Exponent b
Ground	1.34	1.58	−0.085
Machined or cold-drawn	2.70	4.51	−0.265
Hot-rolled	14.4	57.7	−0.718
As-forged	39.9	272.	−0.995

From C. J. Noll and C. Lipson, "Allowable Working Stresses," *Society for Experimental Stress Analysis*, vol. 3, no. 2, 1946 p. 29. Reproduced by O.J. Horger (ed.) *Metals Engineering Design ASME Handbook*, McGraw-Hill, New York. Copyright © 1953 by The McGraw-Hill Companies, Inc. Reprinted by permission.

Figure 6–18

Fatigue strength fraction, f, of S_{ut} at 10^3 cycles for $S_e = S'_e = 0.5S_{ut}$ at 10^6 cycles.

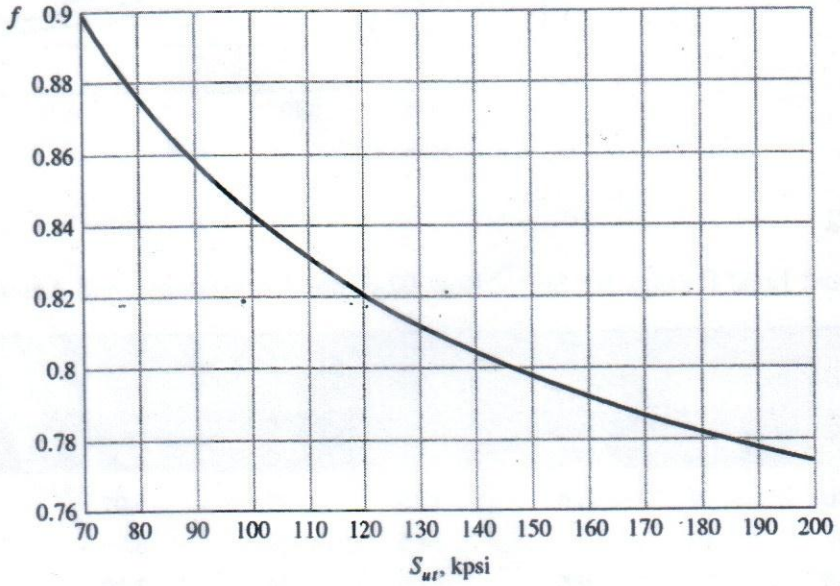


Figure A–15–8

Round shaft with shoulder fillet in torsion. $\tau_0 = Tc/J$, where $c = d/2$ and $J = \pi d^4/32$.

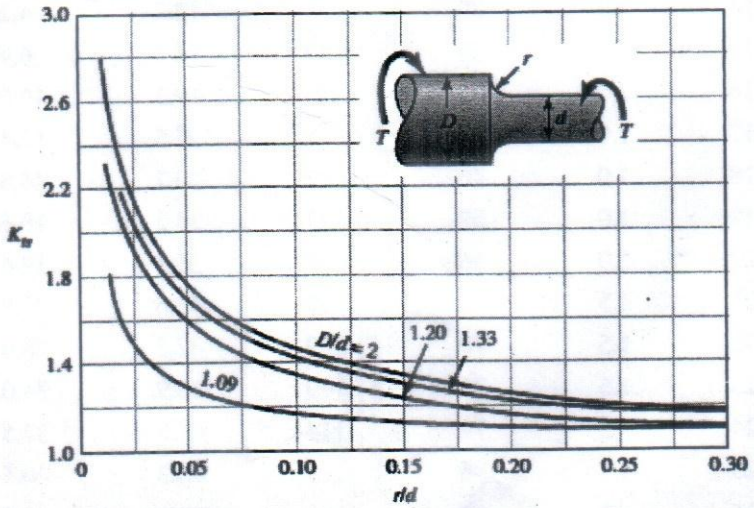


Figure A–15–9

Round shaft with shoulder fillet in bending. $\sigma_0 = Mc/I$, where $c = d/2$ and $I = \pi d^4/64$.

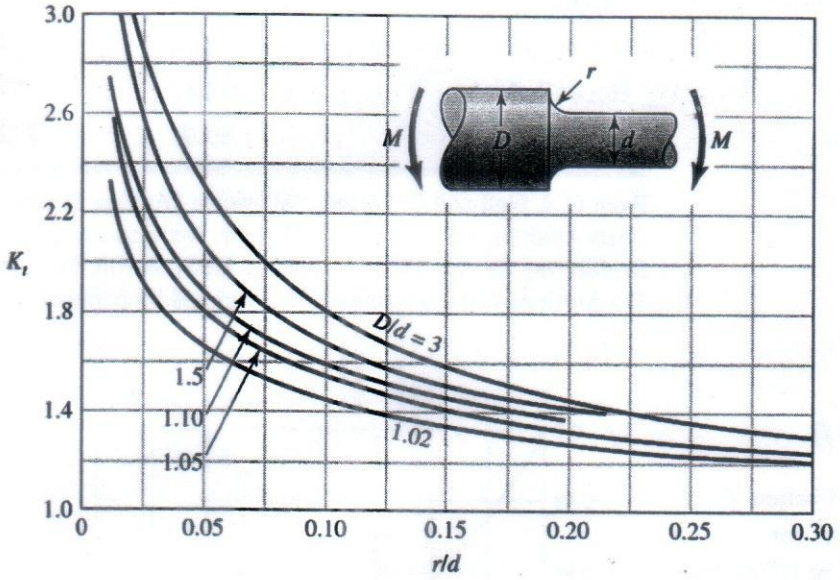


Table 11–2

Dimensions and Load Ratings for Single-Row 02-Series Deep-Groove and Angular-Contact Ball Bearings

Bore, mm	OD, mm	Width, mm	Fillet Radius, mm	Shoulder Diameter, mm		Load Ratings, kN			
						Deep Groove		Angular Contact	
				d_S	d_H	C_{10}	C_0	C_{10}	C_0
10	30	9	0.6	12.5	27	5.07	2.24	4.94	2.12
12	32	10	0.6	14.5	28	6.89	3.10	7.02	3.05
15	35	11	0.6	17.5	31	7.80	3.55	8.06	3.65
17	40	12	0.6	19.5	34	9.56	4.50	9.95	4.75
20	47	14	1.0	25	41	12.7	6.20	13.3	6.55
25	52	15	1.0	30	47	14.0	6.95	14.8	7.65
30	62	16	1.0	35	55	19.5	10.0	20.3	11.0
35	72	17	1.0	41	65	25.5	13.7	27.0	15.0
40	80	18	1.0	46	72	30.7	16.6	31.9	18.6
45	85	19	1.0	52	77	33.2	18.6	35.8	21.2
50	90	20	1.0	56	82	35.1	19.6	37.7	22.8
55	100	21	1.5	63	90	43.6	25.0	46.2	28.5
60	110	22	1.5	70	99	47.5	28.0	55.9	35.5
65	120	23	1.5	74	109	55.9	34.0	63.7	41.5
70	125	24	1.5	79	114	61.8	37.5	68.9	45.5
75	130	25	1.5	86	119	66.3	40.5	71.5	49.0
80	140	26	2.0	93	127	70.2	45.0	80.6	55.0
85	150	28	2.0	99	136	83.2	53.0	90.4	63.0
90	160	30	2.0	104	146	95.6	62.0	106	73.5
95	170	32	2.0	110	156	108	69.5	121	85.0

Table A–20

Deterministic ASTM Minimum Tensile and Yield Strengths for Some Hot-Rolled (HR) and Cold-Drawn (CD) Steels [The strengths listed are estimated ASTM minimum values in the size range 18 to 32 mm ($\frac{3}{4}$ to $1\frac{1}{4}$ in). These strengths are suitable for use with the design factor defined in Sec. 1–10, provided the materials conform to ASTM A6 or A568 requirements or are required in the purchase specifications. Remember that a numbering system is not a specification.] *Source:* 1986 SAE Handbook, p. 2.15.

1	2	3	4	5	6	7	8
UNS No.	SAE and/or AISI No.	Process-ing	Tensile Strength, MPa (kpsi)	Yield Strength, MPa (kpsi)	Elongation in 2 in, %	Reduction in Area, %	Brinell Hardness
G10060	1006	HR	300 (43)	170 (24)	30	55	86
		CD	330 (48)	280 (41)	20	45	95
G10100	1010	HR	320 (47)	180 (26)	28	50	95
		CD	370 (53)	300 (44)	20	40	105
G10150	1015	HR	340 (50)	190 (27.5)	28	50	101
		CD	390 (56)	320 (47)	18	40	111
G10180	1018	HR	400 (58)	220 (32)	25	50	116
		CD	440 (64)	370 (54)	15	40	126
G10200	1020	HR	380 (55)	210 (30)	25	50	111
		CD	470 (68)	390 (57)	15	40	131
G10300	1030	HR	470 (68)	260 (37.5)	20	42	137
		CD	520 (76)	440 (64)	12	35	149
G10350	1035	HR	500 (72)	270 (39.5)	18	40	143
		CD	550 (80)	460 (67)	12	35	163
G10400	1040	HR	520 (76)	290 (42)	18	40	149
		CD	590 (85)	490 (71)	12	35	170
G10450	1045	HR	570 (82)	310 (45)	16	40	163
		CD	630 (91)	530 (77)	12	35	179
G10500	1050	HR	620 (90)	340 (49.5)	15	35	179
		CD	690 (100)	580 (84)	10	30	197
G10600	1060	HR	680 (98)	370 (54)	12	30	201
G10800	1080	HR	770 (112)	420 (61.5)	10	25	229
G10950	1095	HR	830 (120)	460 (66)	10	25	248

B.Sc. Engg (M) 6th Sem — 29 October 2018

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester: A.Y. 2017-2018
Course Code: Math 4611 — Time : 3.0 Hours
Course Title : Numerical Analysis — Full Marks : 150

There are 8 (Eight) Questions. Answer any 6 (Six) Questions.
Figures in the right margin indicate full marks. Don't write on this question paper.
Assume any missing data.

1. a) You are working for a company that makes floats for commodes. You are asked to find the depth to which the ball is submerged when floating in water. The equation that gives the depth x to which the ball is submerged under water is given by **15**

$$X^3 - 0.165X^2 + 3.993 * 10^{-4} = 0$$

Use the false-position method of finding roots of equations to find the depth X to which the ball is submerged under water. Use initial guesses of lower limit $X_L = 0$ and upper limit $X_U = 0.11$. Iterate until the approximate relative error falls below 5%.

b) Explain why the true error of the first derivative of the function y=f(x) gets quartered by halving the Δx in central divided difference scheme. Δx bears usual meaning. **10**

2. a) Derive the equation of the error in a single segment Trapezoidal Rule of Integration in terms of h, where h is the width of the segment. **10**

b) The force on a sailboat mast can be represented by the following function: **15**

$$f(z) = 200\left(\frac{z}{5+z}\right)e^{\frac{-2z}{H}}$$

Where, z = the elevation above the deck and H = the height of the mast. The total force F exerted on the mast can be determined by integrating this function over the height of the mast.

$$F = \int_0^H f(z)\,dz$$

The line of action can also be determined by integration:

$$d = \frac{\int_0^H z\,f(z)\,dz}{\int_0^H f(z)\,dz}$$

Use Simpson's $1/3$ rule to compute F and d for the case where H = 30 (n = 6).

3. a) Use a three point gauss quadrature rule to find the value of the integral **10**

$$\int_{0.1}^{1.3} 5xe^{-2x}\,dx$$

with weighting factors and function arguments given below

$c_1 = 0.5556$	$x_1 = -0.7746$
$c_2 = 0.889$	$x_2 = 0$
$c_3 = 0.5556$	$x_3 = 0.7746$

(Hint: Convert the integration limit to lower limit = -1 and upper limit = 1)

b) The upward velocity of a rocket can be computed by the following formula: **15**

$$v = u \ln\left(\frac{m_0}{m_0 - qt}\right) - gt$$

where v = upward velocity, u = velocity at which fuel is expelled relative to the rocket, m_0 = initial mass of the rocket at time t = 0, q = fuel consumption rate, and g = downward acceleration of gravity (assumed constant = 9.81 m/s^2). If u = 1850 m/s, m_0 = 160,000 kg, and q = 2500 kg/s, determine how high the rocket will fly in 30 s using Romberg Integration with limit of ε_s= 0.005%.

4. a) In a hypothetical, decimal, floating point representation of numbers, show that the maximum error can be found is $5*10^{2-n}$ %, where n is the number of digits for mantissa. **10**

b) The two-dimensional distribution of pollutant concentration in a channel can be described by **15**
$c(x, y) = 7.9 + 0.13x + 0.21y - 0.05x^2 - 0.016y^2 - 0.007xy$
Determine the exact location of the peak concentration given the function. Use gradient search with an initial guess of (x,y)=(0.5,5) and with h=0.2 (h is the distance along h axis). Show the calculation for 5 iterations.

5. a) Suppose that the position of a falling object is governed by the following differential equation: **13**

$$\frac{d^2x}{dt^2} + \frac{c}{m}\frac{dx}{dt} - g = 0$$

Where, c = a first-order drag coefficient = 12.5 kg/s, m = mass=70 kg, t = time(s), and g=gravitational acceleration=9.81m/s^2. Use the shooting method to solve this equation for the boundary conditions: $x(0) = 0$, $x(12) = 500$. While solving in shooting, use the Euler method internally with time step size of 4s. (Hint: Use the guesses $\frac{dx}{dt}(0) = 40$ and $\frac{dx}{dt}(0) = 70$ and then interpolate to find the required $\frac{dx}{dt}$)

b) Solve the following ODE using finite difference method that describe the temperature distribution in a circular rod with internal heat source S **12**

$$\frac{d^2T}{dr^2} + \frac{1}{r}\frac{dT}{dr} + S = 0$$

over the range $0 \le r \le 1$, with the boundary conditions
$T(r = 0) = 0$ and $T(r = 1) = 5$ for S=10 and step size of $\Delta r = 0.2$

6. a) Suppose that a projectile is launched upward from the earth's surface. Assume that the only force acting on the object is the downward force of gravity. Under these conditions, a force balance can be used to derive **13**

$$\frac{dv}{dt} = -g(0)\frac{R^2}{(R + x)^2}$$

where, v = upward velocity (m/s), t = time (s), x = altitude (m) measured upward from the earth's surface, $g(0)$ = the gravitational acceleration at the earth's surface (=9.81 m/s^2), and R = the earth's radius (=6.37×10^6 m). Recognizing that $dx/dt = v$, use Runge Kutta 2nd order method(with Heun's method) to find out the height and velocity from t=0 to t=90 s with step size of 30s if $v(t = 0)$ = 1500 m/s and x(t=0)=0.

b) The motion of a damped spring-mass system (figure 01) is described by the following ordinary differential equation: **12**

$$m\frac{d^2x}{dt^2} + c\frac{dx}{dt} + kx = 0$$

where, x = displacement from equilibrium position (m), t = time (s), m = 20-kg mass, and c = the damping coefficient (N · s/m). The damping coefficient $c = 40$. The spring constant $k = 20$ N/m. The initial velocity is zero, and the initial displacement $x = 1$ m. Solve this equation using a Euler method over the time period $0 \le t \le 15$ s with step size of 3s.

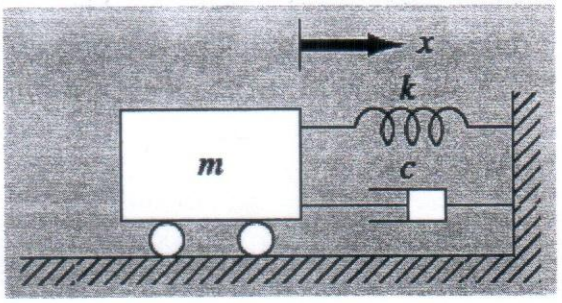


figure 01

7. Find the temperature distribution of the plate given in the figure 02 using finite difference method. All the values in the figure are in ^{0}C. **25**

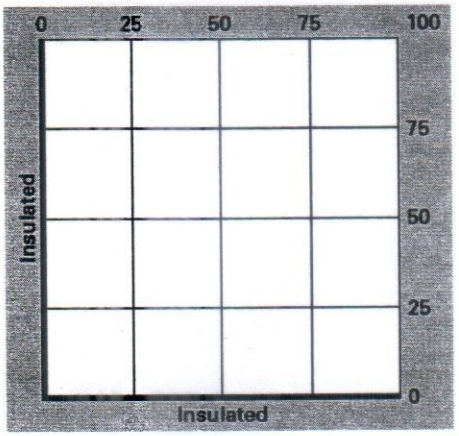


figure 02

8. a) What are the conditions that a numerical solution must satisfy to be convergent? With a simple Ordinary Differential Equation (ODE), show that implicit scheme is unconditionally stable. **7**

b) Use the Crank-Nicolson method to solve for the temperature distribution of a long, thin rod with a length of 10 cm at the time of 0.1 s and 0.2 s with the following values: $\Delta x = 2$ cm, and $\Delta t = 0.1$ s. At $t = 0$, the temperature of the rod is zero and the boundary conditions are fixed for all times at $T(0) = 100^0$C and $T(10) = 50^0$C. Note that the rod is aluminum with $\lambda = 0.020875$, where, λ bears the usual meaning. **18**

B.Sc Engg.(M)/6th Sem
HDME/6th Sem

22 October, 2018

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination
Course No. MCE 4613
Course Title: Convective Heat Transfer, Phase Change and Mass Transfer

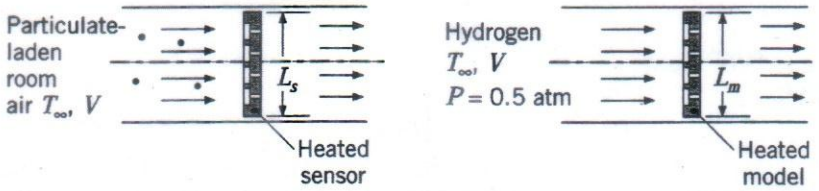
Summer Semester: A.Y. 2017-2018
TIME: 3 Hours
Full Marks: 150

There are 8 (Eight) Questions. Answer any 6 (Six) Questions.

Marks in the Margin indicate full marks. Don't write on this question paper. Symbols carry their usual meanings. Relevant correlations, charts are provided on separate pages with the question. Assume reasonable values for any missing data. Programmable calculators are not allowed.

1. a) Consider a hot boiled egg in a spacecraft that is filled with air at atmospheric pressure and temperature at all times. Will the egg cool faster or slower when the spacecraft is in space instead of on the ground? Explain. [04]
   b) Physically, what does the Grashof number represent? How does the Grashof number differ from the Reynolds number? [03]
   c) How does film boiling differ from nucleate boiling? Is the boiling heat flux necessarily higher in the stable film boiling regime than it is in the nucleate boiling regime? [04]
   d) What are the common causes of fouling in a heat exchanger? How does fouling affect heat transfer and pressure drop? Develop the modified overall heat transfer coefficient relation considering the fouling factors. [10]
   e) At a given temperature and pressure, do you think the mass diffusivity of copper in aluminum will be equal to the mass diffusivity of aluminum in copper? Explain. [04]

2. a) Consider steady, laminar, two-dimensional flow over an isothermal plate. Does the thickness of the velocity boundary layer increase or decrease with (a) distance from the leading edge, (b) free-stream velocity, and (c) kinematic viscosity? [04]
   b) When is heat transfer through a fluid conduction and when is it convection? For what case is the rate of heat transfer higher? How does the convection heat transfer coefficient differ from the thermal conductivity of a fluid? [04]
   c) A microscale detector monitors a steady flow ($T_\infty = 27°C$, $V = 10$ m/s) of air for the possible presence of small, hazardous particulate matter that may be suspended in the room. The sensor is heated to a slightly higher temperature in order to induce a chemical reaction associated with certain substances of interest that might impinge on the sensor's active surface. The active surface produces an electric current if such surface reactions occur; the electric current is then sent to an alarm. To maximize the sensor head's surface area and, in turn, the probability of capturing and detecting a particle, the sensor head is designed with a very complex shape. The value of the average heat transfer coefficient associated with the heated sensor must be known so that the required electrical power to the sensor can be determined Consider a sensor with a characteristic dimension of $L_s = 80$ μm. [13]



A scale model of the sensor is placed in a recirculating (closed) wind tunnel using hydrogen as the working fluid. If the wind tunnel operates at a hydrogen absolute pressure of 0.5 atm and velocity of V = 0.5 m/s, find the required hydrogen temperature and characteristic dimension of the scale model, L_m. The properties are as follows: air (T = 25 °C, 1 atm): $Pr_s = 0.707$, $\nu_s = 15.71 \times 10^{-6}$ m²/s, hydrogen (250 K, 1 atm) Pr = 0.707, $\nu = 81.4 \times 10^{-6}$ m²/s.

d) What is external forced convection? How does it differ from internal forced convection? Can a heat transfer system involve both internal and external convection at the same time? Give an example. [04]

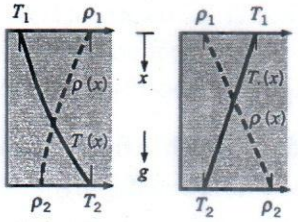
3. a) What is the difference between skin friction drag and pressure drag? Which is usually more significant for slender bodies such as airfoils? [03]

b) How are the average friction and heat transfer coefficients determined in flow over a flat plate? [02]

c) Engine oil at 80°C flows over a 10-m-long flat plate whose temperature is 30°C with a velocity of 2.5 m/s. Determine the total drag force and the rate of heat transfer over the entire plate per unit width. [10]

d) In a geothermal power plant, the used geothermal water at 80°C enters a 15-cm-diameter and 400-m-long uninsulated pipe at a rate of 8.5 kg/s and leaves at 70°C before being reinjected back to the ground. Windy air at 15°C flows normal to the pipe. Disregarding radiation, determine the average wind velocity in km/h. Consider the specific heat of water at 75°C to be 4193 J/kg.°C [10]

4. a) [05]



(i) (ii)

Figures (i) and (ii) show the conditions in a fluid between large horizontal plates at different temperatures for two different cases. What will be the heat transfer modes for these two cases? Give appropriate reasonings.

b) Discuss the effects of turbulence in free convection boundary layers. Which dimensionless number is customarily used for this phenomenon? [04]

c) With figures, distinguish between *free boundary flow* and *plume*. [04]

d) A 6-m-long section of an 8-cm-diameter horizontal hot-water pipe passes through a large room whose temperature is 20°C. If the outer surface temperature of the pipe is 70°C, determine the rate of heat loss from the pipe by natural convection. [12]

5. a) Show the different points and regions of typical boiling curve for water at 1 atm with a neat figure. Explain how burnout is caused. Why is the burnout point avoided in the design of boilers? [08]

b) Using relevant figures, distinguish between condensation mechanisms. Which condensation mechanism would you consider while designing a compact heat exchanger? How would you achieve such type of condensation? Discuss briefly. [09]

c) Discuss different boiling regimes in the order they occur in a vertical tube during flow boiling with a neat diagram. [08]

6. a) Develop an expression for the effectiveness of a parallel flow heat exchanger. [12]

b) What is the heat capacity rate? What can you say about the temperature changes of the hot and cold fluids in a heat exchanger if both fluids have the same capacity rate? What does a heat capacity of infinity for a fluid in a heat exchanger mean? [03]

c) A 2-shell passes and 4-tube passes heat exchanger is used to heat glycerin from 20^0C to 50^0C by hot water, which enters the thin-walled 2-cm-diameter tubes at 80^0C and leaves at 40^0C. The total length of the tubes in the heat exchanger is 60 m. The convection heat transfer coefficient is 25 W/m^2-K on the glycerin (shell) side and 160 W/m^2-K on the water (tube) side. Determine the rate of heat transfer in the heat exchanger (a) before any fouling and (b) after fouling with a fouling factor of 0.0006 m^2-K/W occurs on the outer surfaces of the tubes. [10]

7. a) What do (i) homogeneous reactions and (ii) heterogeneous reactions represent in mass transfer? To what do they correspond in heat transfer? [04]

b) In a mass production facility, steel components are to be hardened by carbon diffusion. Would you carry out the hardening process at room temperature or in a furnace at a high temperature, say 900°C? Why? [03]

c) Discuss Henry's law and Raoult's law for mass transfer. [06]

d) Elaborate the mass diffusion in moving medium. [07]

e) Briefly discuss Reynold's analogy and Chilton-Colburn analogy. [05]

8. a) How is the thermal entry length defined for flow in a tube? In what region is the flow in a tube fully developed? [03]

b) Air flowing through a tube of 75-mm diameter passes over a 150-mm-long roughened section that is constructed from naphthalene having the properties $\mathcal{M}$ = 128.16 kg/kmol and $p_{sat}(300\ K) = 1.31 \times 10^{-4}$ bar. For Naphthalene-air mixture (300K, 1 atm): $D_{AB} = 0.62 \times 10^{-5}$ m^2/s. The air is at 1 atm and 300 K, and the Reynolds number is Re_D = 35,000. In an experiment for which flow was maintained for 3 h, mass loss due to sublimation from the roughened surface was determined to be 0.01 kg. What is the associated convection mass transfer coefficient? What would be the corresponding convection heat transfer coefficient? Contrast these results with those predicted by conventional smooth tube correlations. [11]

c) Hot air flows with a mass rate of $\dot{m}$ = 0.050 kg/s through an uninsulated sheet metal duct of diameter D = 0.15 m, which is in the attic of a house. The hot air enters at 103^0C and, after a distance of L = 5 m, cools to 85^0C. The heat transfer coefficient between the duct outer surface and the ambient air at $T_\infty = 0^0$C is known to be h_o = 6 W/m^2 - K. [11]

1. Calculate the heat loss (W) from the duct over the length L.
2. Determine the heat flux and the duct surface temperature at x = L

B.Sc.Eng (6th Sem (MCE), BScTE (2nd Sem) and HDME (6th Sem) 24 October 2018

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester, A.Y. 2017-2018
Course No. MCE 4621/MCE 4691 — TIME :3 hours
Course Title: Machine Tools — Full Marks :150

There are **8** (EIGHT) Questions. Answer any **6** (SIX) of them.
Marks in the Margin indicate the full marks.

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1 Under a set of given cutting conditions, different spindle speeds can be determined using the various stepped regulations. Suppose the linear speed of a spindle is v m/min and one of the variable spindle speeds is n_x. 25

i. Determine the general expression for diameter range (mm) to be cut using the indicated parameters. (5 marks)

ii. For a z discrete number of speed steps, write down the formuals for $n_1, n_2, n_3, \dots, n_{z-1}, n_z$ when rpm values constitute harmonic progression. (8 marks)

iii. Suppose spindle speed (rpm) limits could be between 20 and 500 and there are maximum 8 speed steps. Find these speed steps in harmonic progression and comment on these steps. (12 marks)

2 a) Clearly discuss why the geometric progression of speed steps is preferred over other progressions. Use all the relevant mathematical expressions or relationships. 10

b) Suppose the spindle rpm values constitute 30, 45, 65, 95, 135, 185, 245 and 325. The optimum cutting speed v m/min will lie within this rpm range. Take a workpiece diameter between 200 and 300 mm (any value), determine 15

i. The range of linear speeds at which its optimum value will lie.

ii. The optimum cutting speed when loss of economic cutting speed is maximum.

iii. Maximum loss of economic cutting speed, and

iv. Productivity of machining operation when feed per revolution is 2 mm for cutting speed found under (ii).

3 a) What is meant by range ratio used in designing a speed box? Explain its physical significance in metal cutting by different machine tools. Why is it kept high in case of, say, center lathe and low in case of, say, grinding machines? 10

b) Choose a range ratio for milling operation from the range 30-50. Determine the geometric progression ratio for a 12 number of speed steps. For $\phi = 1.26$ what would be the number of speed steps? 7

c) Copy and complete the following table in your answer booklet when rolled bar diameter interval is 400-600 mm for $d_{j-1} \geq \frac{\Delta d_b . \phi}{(\phi - 1)}$, where symbols stand for their usual meanings. 8

ϕ	1.06	1.12	1.26	1.41	1.58
d_{j-1}					

4 a) Suppose there are 4 transmission groups and their nature of speed steps are as such: first and third are identical and the rest are distinct. How many total combinations of speed steps are possible? 5

b) In aforesaid transmission groups (Q4a), rpm values of output shaft of the box follow geometric progression and $\phi = 1.41$. Determine the progression ratios of all groups. If the total number of speed steps is 24, write down the stuctural formulae under one combination. 15

c) Draw the structural diagrams of any two of them in one piece of graph paper (side by side). 5

5 In a machine operation constituting feed rates in geometric progression, the limiting transmission ratios are $i_{max} \leq 2.8, i_{min} \geq 1/5$. Design a feed box for feed/rev in the range of 0.15-1.25 mm/rev in two stages when $\phi = 1.12$. Assume the number of feed steps to be 8. Determine 25

i. The group transmission range and deed range (2 marks)
ii. Write the possible structural formuale (4 marks)
iii. Draw two structural diagrams in one piece of graph paper (5 marks)
iv. Draw the kinematic diagram of transmission based on a structural diagram (6 marks)
v. Prepare the feed chart (ray diagram) for one structural formual when kinematic balance follows $n_{III}.i.\pi mN$ = s, where i = the transmission ratio of worm-worm gear is 1/50, m = module of pinion is 4, N = no. of teeth of pinion is 12. Also, suppose the rotation from spindle is transmitted to shaft I through gear pairs 40-60, 25-62, and 32-42 teeth. (8 marks).

6 a) For selecting a motor for a particular drive, we need to consider several mechanical characteristics and other factors. Mention at least eight factors or characteristics. 8

b) What are the methods commonly used determination of motor rating for variable load drives? 4

c) Suppose you have been asked to select a motor to be used in metal shearing lathes. Average shearing forces is taken to be 5,000 kg while velocity of shearing would be 20 m/min and the mechanical efficiency of the lathe varies between 70-80%. Estimate the power rating. 5

d) What do people mean by motor protection and maintenance. Give a list of issues on motor protection and maintenance. 8

7 a) In a special case of gear box design, suppose overlapping of speed steps is a necessity. The parameters are $R_n = 20$, $\phi = 1.12$. 12

i. Determine the number of normal speed steps and its structural formula.
ii. Write down the corrected structural formula.
iii. Draw the structural diagram (in graph paper or free-hand sketch).

b) What do you understand by speed box with a combined structure? Draw a block diagram and label its different components. For $R_n = 70$, and $\phi = 1.26$, 13

i. Determine the number of speed steps
ii. Break up of the selected number of speed steps.
iii. Write down the structural formula, when the limiting value of X_u is 9.

Hint: $X_{1h} = X_{1l} = p_{1c} \cdot p_{2c} \cdot p_{3c} \cdots p_{nc}$; $X_{2h} = X_{1h} \cdot p_{1h}$
$X_{mh} = X_{1h} \cdot p_{1h} \cdot p_{2h} \cdot \cdots p_{(m-1)h}$; $X_{2l} = X_{1l} \cdot p_{1l}$; $X_{nl} = X_{1l} \cdot p_{1l} \cdot p_{2l} \cdot \cdots p_{(k-1)l}$

8 a) What do you understand by accuracy and repeatability in machine tools? What are the possible errors that might occur during machine operations? Explain adequately with diagrams. 10

b) Write short notes on machine tools 15

i. Geometric errors
ii. Levelling of machine tools
iii. Testing of machine tools

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B.Sc. Engg. (ME)/HDME (6th Semester) October 26, 2018. (Friday)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester, A. Y. 2017-2018
Course No.: MCE 4627 — Time: 3 Hour 00 Min(s)
Course Title: Tool Engineering — Full Marks: 150

There are 8 (Eight) questions. Answer any 6 (Six) questions.

Marks in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper.

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1. a) What are the differences between locators and clamps? Explain briefly with neat sketches the different forms of locations for internal and external surface supports? 15
   b) Explain briefly the different locating guidelines and hence explain the 3-2-1 locating principle. 10
2. a) Write down the differences with necessary diagram between cylindrical locators, jack pin locators and Vee-locators. 12
   b) What are the basic requirements of a good clamping device? List the different types of clamping device and hence explain briefly the working mechanism of a strap clamp. 13
3. a) Explain in details the different factors that need to be considered for the design of Jigs and Fixture. 10
   b) Explain in details the working mechanism of a template jigs and box-type jigs. 11
   c) Why fixture is needed? List the different types of fixture used in manufacturing industries. 4
4. a) Write down the differences between conceptual design and embodiment design and explain the different discrete steps involved in tool design processes mentioning important techniques used in each steps. 17
   b) What is the function of weighted objectives method and value engineering method? 8
5. a) What is parallel plate model and how does this model can be used to find out the share strain rate during the chip formation processes? 15
   b) What do you mean by tool signature of a single point cutting tools and hence explain the details with necessary diagram the tool geometry of a single point cutting tool? 10
6. a) Explain with neat sketches the different drill point features that need to be considered for the design of a twist drill used in drilling operation. 12
   b) Classify the different types of milling cutter used in milling operations and explain the construction details of a plain milling cutter with necessary illustration. 13
7. a) What are the different steps and contents need to be followed for the design and development of a die? How the punch force and stripping force can be calculated in punching processes? 15
   b) List the different types of die used in manufacturing industries and explain the differences between the compound dies and progressive dies. 10
8. a) Explain with necessary examples the economic viability analysis and explain the necessity of using jigs and fixtures in any possible mode of manufacturing processes. 12
   b) What are the parameters that need to be considered for the estimation of die cost and explain with necessary examples the different cost involvement components in die cost estimation process used in die manufacturing industries? 13

BSc. Eng. (M) 6th Sem.
HDME 6th Sem.

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26 October 2018 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester A.Y. 2017-2018
Course Code: MCE 4663 — Time : 3 hours
Course Title: **Automatic Control Engineering** — Full Marks : 150

There are **8(Eight)** Questions. Answer any **6(Six)** of them.
Programmable calculators are not allowed. Don't write on this question paper.

Figures in the right margin indicate full marks

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1. Using the *Laplace Transform*, obtain the *time response* for the following system subject to the input and initial conditions specified below (25)

$$\frac{d^3y}{dt^3}+3\frac{d^2y}{dt^2}+2\frac{dy}{dt}=2\frac{du}{dt}+3u$$

$$u = \begin{cases} 1 & t > 0 \\ 0 & t \le 0 \end{cases}$$

$$y(0)=1 \qquad \dot{y}(0)=-1 \qquad \ddot{y}(0)=2$$

2. a) Find the differential equations relating the movement θ of the control surface to the input displacement x of the valve of the hydraulic actuator shown in following system(Fig.1). (15)

   b) Find the linear approximation to the equations of motion when $\dot{y}$=constant, with and without an applied load-that is, when $F \neq 0$ and $F=0$. Assume that θ motion is small. (10)

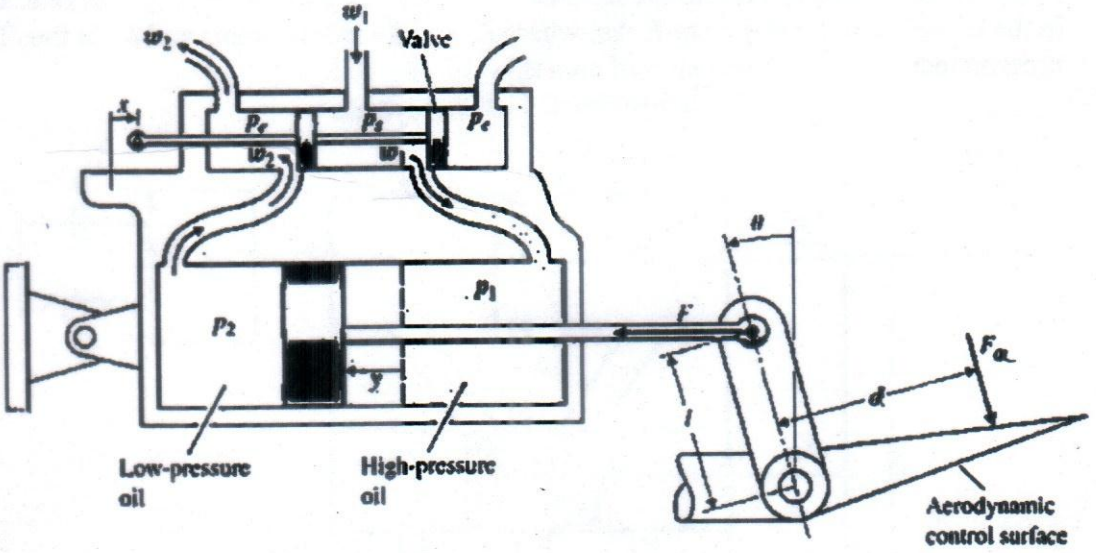

Fig.1

3. An electric motor has the rotational differential equation for motor speed, $v(t)$ (rad/sec) versus input electric potential, $u(t)$ (volts) shown below (25)

$$\dot{v}(t) = -3v(t) + 2v(t)u(t) + 100u(t)$$

   a) Find the equilibrium value(s) of $u(t)= u_{equil}$ corresponding to an operating speed of $v(t) = 100$ rad/sec.

   b) Find the *linearized* ordinary differential equation about the equilibrium point found in part (a).

4. a) Represent the following rotational system (Fig.2) in **state space**, where $\theta_3(t)$ is the output. (15,

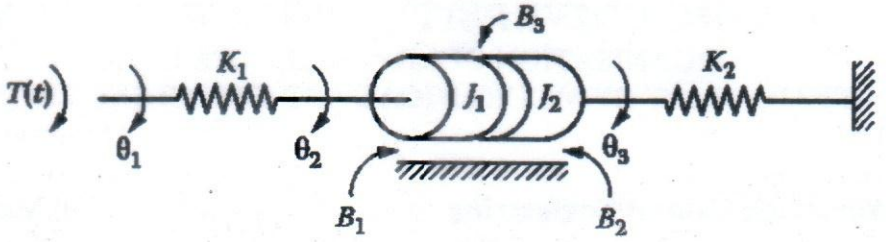

Fig.2

b) Determine the *transfer function* for the mechanical system (Fig. 3) shown below, with force *f* as input and displacement *x* as output. All other symbols have their usual meanings. (10)

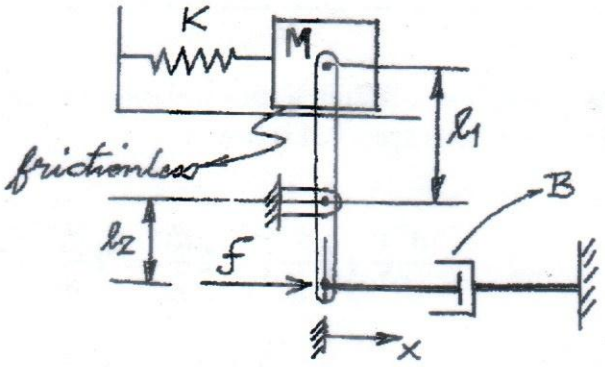

Fig. 3

5. Use the Routh stability criterion to determine the number of roots in the left-half plane, the right-half plane, and on the imaginary axis for the given characteristic equation: (25)

$$s^7 + 5s^6 + 9s^5 + 9s^4 + 4s^3 + 20s^2 + 36s + 36 = 0$$

6. A hydraulic servo system (Fig.4) used to control the transverse feed of a machine tool shown in the following figure. Each angular position of the cam corresponds to a desired reference position y_r such that $x=K_r y_r$. The load on the piston is that due to tool reactive force and may be assumed to consist of mass *M*, friction *B* and spring with constant *K*. Draw a block diagram and obtain therefrom the transfer function $Y(s)/Y_r(s)$, assuming that rate of oil flow in the power cylinder is $q=K_1 e-K_2\Delta p$, where K_1 and K_2 are constants and Δp is the differential pressure across the power piston of area *A*. (25)

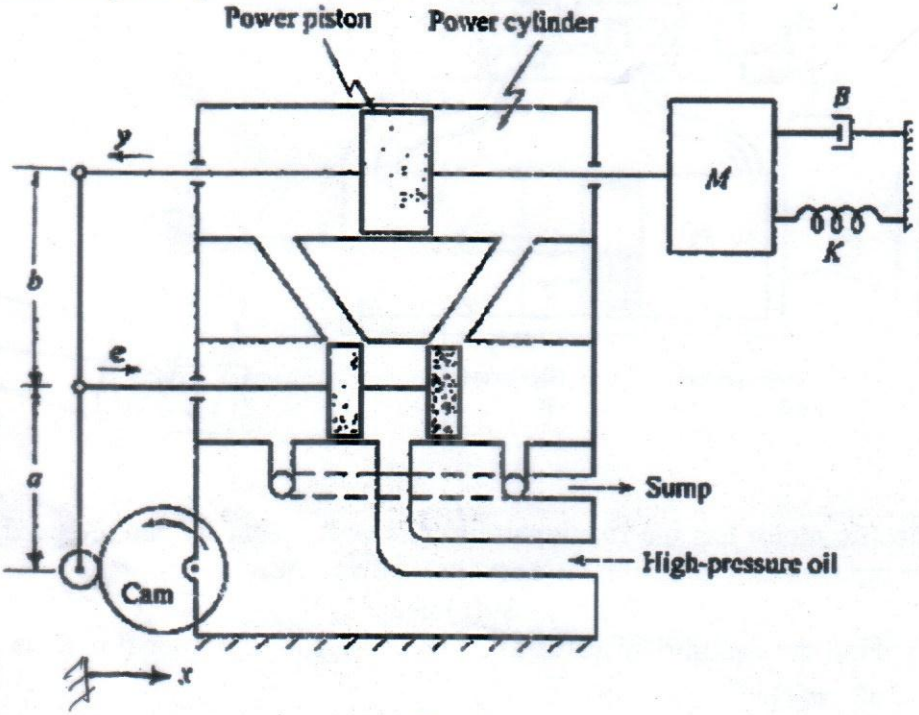

Fig.4

7. Showing clearly Angles of asymptotes, Centroids, Break away points, Angle of departure, Sketch the complete root locus for the system having (25)

$$G(s)H(s)=\frac{K(s+5)}{s^2+4s+20}$$

8. a) Find M and K, shown in the system of Fig.5, to yield $x(t)$ with 16% overshoot and 20 seconds settling time for a step input in motor torque, $T_m(t)$ (13)

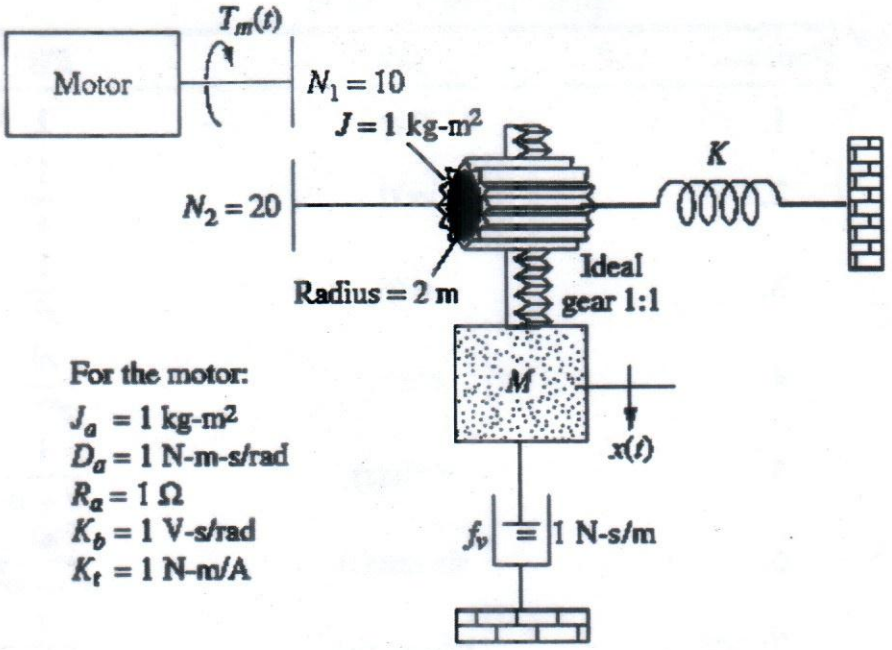

Fig. 5

b) Given the block diagram of a mechanical system in following figure (12)

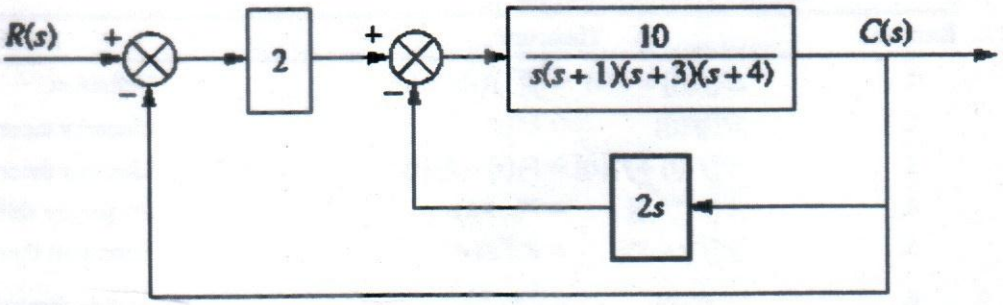

Fig. 6

Find the following:

i. The closed-loop transfer function
ii. The system type
iii. The steady-state error for an input of 5u(t)
iv. The steady-state error for an input of 5tu(t)
v. Discuss the validity of your answers to Parts c and d.

Laplace transform table

Item no.	$f(t)$	$F(s)$
1.	$\delta(t)$	1
2.	$u(t)$	$\frac{1}{s}$
3.	$tu(t)$	$\frac{1}{s^2}$
4.	$t^n u(t)$	$\frac{n!}{s^{n+1}}$
5.	$e^{-at}u(t)$	$\frac{1}{s+a}$
6.	$\sin \omega t u(t)$	$\frac{\omega}{s^2+\omega^2}$
7.	$\cos \omega t u(t)$	$\frac{s}{s^2+\omega^2}$

Laplace transform theorems

Item no.	Theorem		Name
1.	$\mathcal{L}[f(t)] = F(s)$	$= \int_{0-}^{\infty} f(t)e^{-st}dt$	Definition
2.	$\mathcal{L}[kf(t)]$	$= kF(s)$	Linearity theorem
3.	$\mathcal{L}[f_1(t)+f_2(t)]$	$= F_1(s)+F_2(s)$	Linearity theorem
4.	$\mathcal{L}[e^{-at}f(t)]$	$= F(s+a)$	Frequency shift theorem
5.	$\mathcal{L}[f(t-T)]$	$= e^{-sT}F(s)$	Time shift theorem
6.	$\mathcal{L}[f(at)]$	$= \frac{1}{a}F\left(\frac{s}{a}\right)$	Scaling theorem
7.	$\mathcal{L}\left[\frac{df}{dt}\right]$	$= sF(s)-f(0-)$	Differentiation theorem
8.	$\mathcal{L}\left[\frac{d^2f}{dt^2}\right]$	$= s^2F(s)-sf(0-)-f'(0-)$	Differentiation theorem
9.	$\mathcal{L}\left[\frac{d^nf}{dt^n}\right]$	$= s^nF(s)-\sum_{k=1}^{n}s^{n-k}f^{k-1}(0-)$	Differentiation theorem
10.	$\mathcal{L}\left[\int_{0-}^{t} f(\tau)d\tau\right]$	$= \frac{F(s)}{s}$	Integration theorem
11.	$f(\infty)$	$= \lim_{s\to 0} sF(s)$	Final value theorem[1]
12.	$f(0+)$	$= \lim_{s\to \infty} sF(s)$	Initial value theorem[2]

B.Sc/HDME 6th Semester 43 26October 2018 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

SEMESTER FINAL EXAMINATION SUMMER SEMESTER: 2017-2018

Course No: MCE-4685 TIME:3HR

Course Name: Automotive Technology(II) FULL MARKS: 150

There are **Eight (8)** Questions. Answer any **Six (6)** Questions.
Figures in the Margin indicate full marks. Do not write on this question paper.

1	a)	Write the classification of steering system in automobiles. Explain mechanical and hydraulic steering system with proper labelled diagrams.	(13)
	b)	Write the advantages and disadvantages of installing transaxle in vehicles.	(4)
	c)	Draw a layout for electrically controlled steering system. Explain its pros and cons.	(8)
2	a)	Briefly explain different arrangements of engine in automobiles. Write the significance of each arrangement.	(8)
	b)	Write objectives of differential gear box installation in vehicles. Explain the difference between conventional and limited slip differential gear box with labelled diagrams.	(12)
	c)	Briefly explain engagement and disengagement of clutch system in automobiles.	(5)
3	a)	Elaborate the Transmission power flow of five speed automatic transmission with labeled schematic diagrams.	(15)
	b)	Briefly explain working principle of torque converter in automatic transmission system.	10
4	a)	Demonstrate the importance of installing stator in Torque Converter?	(5)
	b)	Draw a graph for demonstration of drive shaft yoke speed fluctuations. Why do manufacturers recommend installation of CV joint for front engine FWD arrangement? Explain.	(10)
	c)	Elaborate the Transmission power flow of five speed manual transmission with labelled schematic diagrams.	(10)
5	a)	Write the function of brakes in automobiles. Provide detailed explanation for working principle of Drum and Disc brakes with proper labelled diagrams.	(20)
	b)	Briefly explain difference between torsion bar and coil spring.	(5)
6	a)	How does planetary gears work in automatic power transmission? Explain maximum forward direction and fast reverse with proper diagrams and significant details.	(20)
	b)	What is antilock braking system? Why this ABS system is preferred over conventional braking system?	(5)

B.Sc/HDME 6th Semester **26October 2018 (Morning)**

7 a) What are the main components used in Macpherson strut suspension system? Explain how shock is absorbed through this system in automobiles. **(10)**

b) Write the principle and main components of hydraulic brake system. Explain its operational principle in detail with labelled diagrams. **15**

8 a) Why leaf spring is installed in heavy vehicles? Explain working of this type of suspension system. **(10)**

b) Write and explain gear shift mechanism components in both manual and automatic power transmission vehicles. Draw proper diagrams. **(15)**

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B.Sc.Engg. (M)/ 8th Sem

29 October, 2018

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

FINAL SEMESTER EXAMINATION

MCE-4803 Vibration and System Dynamics

SUMMER SEMESTER: 2017-2018

TIME : 3 HRS

FULL MARKS : 150

There are **Eight** Questions. Answer any **Six** Questions.

Figures in the Right Margin indicate full marks. (Assume reasonable value if any data missing)

Programmable calculators are not allowed. Do not write on this question paper

1. a) The rotor of the turbine of a ship has a mass of 2500 kg and rotates at a speed of 3200 rpm counter clockwise when viewed from the stern. The rotor has radius of gyration of 0.4 m. Determine the gyroscopic couple and its effect when (15)
   i) The ship steers to the left in a curve of 80 m radius at a speed of 15 knots (1 knot =1860 m/h)
   ii) The ship pitches 5 degrees below the normal position and the bow is descending with its maximum velocity-the pitching motion is simple harmonic with a periodic time of 40 seconds
   iii) The ship rolls and at the instant, its angular velocity is 0.4 rad/s clockwise when viewed from stern.
   iv) Also find the maximum angular acceleration during pitching.

   b) A flywheel having a mass of 20 kg and a radius of gyration of 300 mm is given a spin of 500 rpm about its axis which is horizontal. The flywheel is suspended at a point that is 250 mm from the plane of rotation of the flywheel. Determine the rate of precession of the wheel. (10)

2. A rear engine automobile is travelling along a curved track of 120 m radius. Each of the four wheels has a moment of inertia of 2.2 kg/m^2 and an effective diameter of 600 mm. The rotating parts of the engine have a moment of inertia of 1.25 kg-m^2. The gear ratio of the engine to the back wheel is 3.2. The engine axis is parallel to the rear axle and the crankshaft rotates in the same sense as the road wheels. The mass of the vehicle is 2050 kg and the centre of mass is 520 mm above the road level. The width of the track is 1.6 m. What will be the limiting speed of the vehicle if all the four wheels maintain contact with the road surface? (25)

3. a) Derive the expression of velocity and acceleration when the roller has contact with straight flanks in symmetrical tangent cam. (12)

   b) The following particulars relate to a symmetrical tangent cam operating a roller follower: Least radius = 30 mm; Nose radius = 24 mm; Roller radius = 17.5 mm; Distance between cam shaft and nose centre = 23.5 mm; Angle of action of cam = 150^0; Cam shaft speed = 600 rpm. Assuming that there is no dwell between ascent and descent, determine the lift of the valve and the acceleration of the follower at a point where straight flank merges into the circular nose. (13)

4. A two cylinder uncoupled locomotive has inside cylinders 0.6 m apart. The radius of each crank is 300 mm and are at right angles. The revolving mass per cylinder is 250 kg and the reciprocating mass per cylinder is 300 kg. The whole of the revolving and two-third of the reciprocating masses are to be balanced and the balanced masses are placed, in the planes of rotation of the driving wheels, at a radius of 0.8m. The driving wheels are 2 m in diameter and 1.5 m apart. If the speed of the engine is 80 km/hr, determine: i) the hammer blow, ii) maximum variation in tractive effort, and iii) maximum swaying couple. (25)

5. The reciprocating masses of the first three cylinders of a four cylinder engine are 4.1, 6.2 and 7.4 tonnes respectively. The centre lines of the three cylinders are 5.2 m, 3.2 m and 1.2 m from the fourth cylinder. If the cranks for all the cylinders are equal, determine the reciprocating mass of the fourth cylinder and the angular position of the cranks such that the system is (25)

completely balanced for the primary force and couple. If the cranks are 0.8 m long, the connecting rods are 3.8 m, and the speed of the engine is 75 rpm, determine the maximum unbalanced secondary force and the crank angle at which it occurs.

6. a) A flywheel is mounted on a vertical shaft placed at 0.6 m from the bottom end where the length of the shaft is 1.5 m. The both ends of the shaft are fixed and its diameter is 50 mm. The flywheel has a mass of 500 kg. Determine the natural frequencies of longitudinal and transverse vibrations. Take E=200 GPa. (12)

b) A shaft 1.5 m long is supported in flexible bearings at the ends and carries two wheels each of 50 kg mass. One wheel is situated at the centre of the shaft and the other at a distance of 0.4 m from the centre towards right. The shaft is hollow of external diameter 75 mm and inner diameter 37.5 mm. The density of the shaft material is 8000 kg/m^3. The Young's modulus for the shaft material is 200 GPa. Determine the frequency of transverse vibration. (13)

7. Construct the profile of a cam to suit the following specifications: Cam shaft diameter=40 mm; Least radius of cam = 25 mm; Diameter of roller = 25 mm; Angle of lift =120^0; Angle of fall = 150^0; Lift of the follower = 40 mm; Number of pauses are two of equal interval between motions. During the lift, the motion is simple harmonic and during the fall the motion is uniform acceleration and deceleration. The speed of the cam shaft is uniform. The line of stroke of the follower is off-set 12.5 mm from the centre of the cam. (25)

8. A reciprocating IC engine is coupled to a centrifugal pump through a pair of gears. The shaft from the flywheel of the engine to the gear wheel has a 48 mm diameter and is 800 mm long. The shaft from the pinion to the pump has 32 mm diameter and is 280 mm long. The pump speed is four times the engine speed. Moments of inertia of the flywheel, gear-wheel, pinion and pump impeller are 1000 kg-m^2, 14 kg-m^2, 5 kg-m^2 and 18 kg-m^2 respectively. Determine the natural frequency of the torsional oscillations of the system. Take G=80 GPa. (25)

B.Sc Engg. (M)/8th Sem
B.ScTE/2nd Sem (1Yr) and B.ScTE/4th Sem (2Yr)

22 October, 2018

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination
Course No. MCE 4805/MCE 4893
Course Title: Power Plant Engineering

Summer Semester: A.Y. 2017-2018
TIME: 3 Hours
Full Marks: 150

There are 8 (Eight) Questions. Answer any 6 (Six) Questions.
Marks in the Margin indicate full marks. Don't write on this question paper. Symbols carry their usual meanings. Assume reasonable values for any missing data. Programmable calculators are not allowed.

1. a) With necessary diagrams, discuss the change in pressure and velocity in *Impulse turbines* and *Reaction turbines*. [10]
   b) How would you design a *Fluidized bed boiler*? Briefly discuss the steps. [07]
   c) Discuss the steps for designing *Diesel power plants*. [08]

2. a) Upon defining the *Fluidized bed combustion*, elaborate its transition from *Fixed bed* to *Turbulent fluidized bed* with appropriate figures. [10]
   b) Briefly explain different *turbine losses* in *Steam turbines*. [12]
   c) How do you represent the relationship between load and steam consumption (i.e., *throttle flow* of steam) of a *Steam turbine*? [03]

3. a) What parameters are essential for economic design of *HRSG*? Discuss briefly. [10]
   b) Shortly discuss the different types of *turbines* used in *Hydroelectric power plants*. [05]
   c) With the help of a flow diagram, discuss *Liquid Metal Fast Breeder Reactor (LMFBR) power plants*. [10]

4. Briefly discuss the modifications that could be adopted to substantially improve the performance of real *Brayton cycles* using appropriate diagrams. [25]

5. a) With the help of a neat sketch, describe the working principle of a typical *BFBC boiler*. [08]
   b) Write short notes on i) *Fuel injection equipment, and ii) Supercharger* in *Diesel Power Plants*. [04+06]
   c) Distinguish between different types of *Nuclear reactions* that could be used for electricity generation. [07]

6. a) Briefly discuss the essential elements of a *Hydroelectric power plant*. [15]
   b) Briefly discuss how thermal energy can be obtained from *Nuclear reactions*. [05]
   c) Draw a *T-s diagram* depicting *compressor intercooling* and *turbine reheat* for *Gas Turbine Power plants*. [05]

7. a) Elaborate the importance of *hydro-thermal mix* for electricity generation. [05]
   b) With the help of a neat schematic diagram, discuss the *fuel oil system* in *Diesel power plants*. [07]
   c) Elaborate on the various parts of a *Nuclear reactor*, draw diagrams when necessary. [13]

8. a) Draw a conceptual design for *Deuterium-Tritium (D-N) fusion power plant.* [06]
   b) Develop the relationship of *pressure ratio* that would yield the *maximum net work output* in real *Brayton cycle*. [10]
   c) Discuss the different types of *Dam* used in *hydroelectric power plants.* [09]

B Sc. Engg.(M) 8th Sem 26 October, 2018

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — **Summer Semester, A.Y. 2017-2018**
Course Code: **MCE 4813** — Time : **3.0 Hours**
Course Title: **Heat and Mass Transfer** — Full Marks : **150**

There are **Eight (08)** Questions. Answer any **Six (06)** of them.
Do not write on question paper. Marks in the Margin indicate the full marks. Assume any data if necessary.

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1 a) Consider a cylindrical shell (as shown in **Fig. 1**) of length L, inner radius r_1, and outer radius r_2 whose thermal conductivity varies linearly as: $k(T) = k_0(1 + \beta T)$ in a specified temperature range, where k_0 and β are two specified constants. The inner surface of the shell is maintained at a constant temperature of T_1, while the outer surface is maintained at T_2. Assuming steady one dimensional heat transfer, obtain a relation for (a) the heat transfer rate through the wall and (b) the temperature distribution T(r) in the shell. **(12)**

b) When a long section of a compressed air line passes through the outdoors, it is observed that the moisture in the compressed air freezes in cold weather, disrupting and even completely blocking the air flow in the pipe. To avoid this problem, the outer surface of the pipe is wrapped with electric strip heaters and then insulated (as shown in **Fig. 2**). Consider a compressed air pipe of length L = 6 m, inner radius r_1 =3.7 cm, outer radius r_2 = 4.0 cm, and thermal conductivity k = 14 W/m.°C equipped with a 300-W strip heater. Air is flowing through the pipe at an average temperature of -10°C, and the average convection heat transfer coefficient on the inner surface is h = 30 W/m^2.°C. Assuming 15 percent of the heat generated in the strip heater is lost through the insulation, (a) express the differential equation and the boundary conditions for steady one-dimensional heat conduction through the pipe, (b) obtain a relation for the variation of temperature in the pipe material by solving the differential equation, and (c) evaluate the inner and outer surface temperatures of the pipe. **(13)**

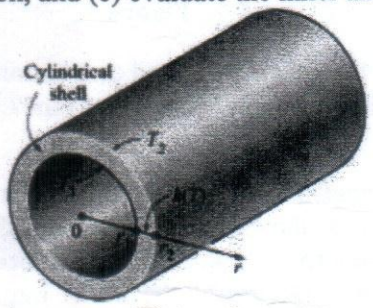

Figure 1

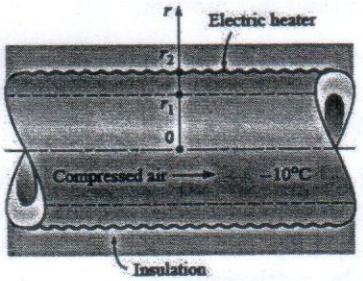

Figure 2

2 a) Consider a cold aluminum canned drink (as shown in **Fig. 3**) that is initially at a uniform temperature of 3°C. The can is 12.5 cm high and has a diameter of 6 cm. If the combined convection/radiation heat transfer coefficient between the can and the surrounding air at 25°C is 10 W/m^2.°C, determine how long it will take for the average temperature of the drink to rise to 10°C. In an effort to slow down the warming of the cold drink, a person puts the can in a perfectly fitting 1-cm-thick cylindrical rubber insulation (k = 0.13 W/m.°C). Now how long will it take for the average temperature of the drink to rise to 10°C? Assume the top of the can is not covered. **(12)**

b) Consider a roof of a house (as shown in **Fig. 4**) consists of a 3–cm-thick concrete slab (k = 2 W/m.°C) that is 15 m wide and 20 m long. The convection heat transfer coefficients on the inner and outer surfaces of the roof are 5 and 12 W/m^2.°C, respectively. On a clear winter night, the ambient air is reported to be at 10°C, while the night sky temperature is 100 K. The house and the interior surfaces of the wall are maintained at a constant temperature of 20°C. The emissivity of both surfaces of the concrete roof is 0.9. Considering both radiation and convection heat transfers, determine the rate of heat transfer through the roof, and the inner surface temperature of the roof. If the house is heated by a furnace burning natural gas with an **(13)**

efficiency of 80 percent, and the price of natural gas is \$0.60/therm (1 therm = 105,500 kJ of energy content), determine the money lost through the roof that night during a 14-h period.

Figure 3

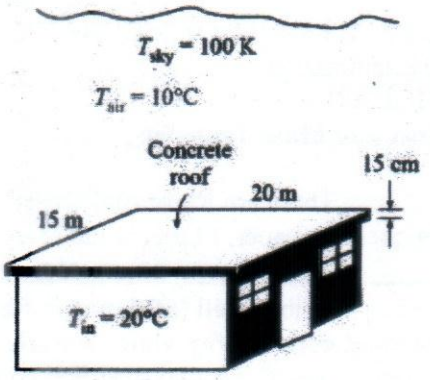

Figure 4

3 a) Obtain a relation for the time required for a lumped system to reach the average temperature (Ti - Tα), where, Ti is the initial temperature and Tα is the temperature of the environment. **(12)**

b) Chickens with an average mass of 1.7 kg (k = 0.45 W/m.°C and α= 0.13 x 10^{-6} m^2/s) initially at a uniform temperature of 15°C are to be chilled in agitated brine at -10°C as shown in **Fig. 5**. The average heat transfer coefficient between the chicken and the brine is determined experimentally to be 440 $W/m^2 \cdot °C$. Taking the average density of the chicken to be 0.95 g/cm^3 and treating the chicken as a spherical lump, determine the center and the surface temperatures of the chicken in 2 h and 30 min. Also, determine if any part of the chicken will freeze during this process. **(13)**

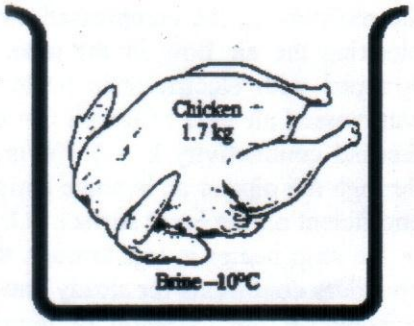

Figure 5

4 a) What is external forced convection? How does it differ from internal forced convection? Can a heat transfer system involve both internal and external convection at the same time? Give an example. **(05)**

b) During air cooling of potatoes, the heat transfer coefficient for combined convection, radiation, and evaporation is determined experimentally as shown in **Table 1**. Consider a 10-cm-diameter potato initially at 20°C with a thermal conductivity of 0.49 W/m/°C. Potatoes are cooled by refrigerated air at 5°C at a velocity of 1 m/s. Determine the initial rate of heat transfer from a potato, and the initial value of the temperature gradient in the potato at the surface. **(05)**

c) Solar radiation is incident on the glass cover of a solar collector at a rate of 700 W/m^2 as shown in **Fig. 6**. The glass transmits 88 percent of the incident radiation and has an emissivity of 0.90. The entire hot water needs of a family in summer can be met by two collectors 1.2 m high and 1 m wide. The two collectors are attached to each other on one side so that they appear like a single collector 1.2 m X 2 m in size. The temperature of the glass cover is measured to be 35°C on a day when the surrounding air temperature is 25°C and the wind is blowing at 30 km/h. The effective sky temperature for radiation exchange between the glass cover and the open sky is -40°C. Water enters the tubes attached to the absorber plate at a rate of 1 kg/min. Assuming the back surface of the absorber plate to be heavily insulated and the only heat loss to occur through the glass cover, determine (a) the total rate of heat loss from the collector, (b) the collector efficiency, which is the ratio of the amount of heat transferred to the water to the solar energy incident on the collector, and (c) the temperature rise of water as it flows through the collector. **(15)**

Table 1: Heat transfer coefficient for combined convection, radiation, and evaporation

V, m/s	h, W/m^2.°C
0.66	14.0
1.00	19.1
1.36	20.2
1.73	24.4

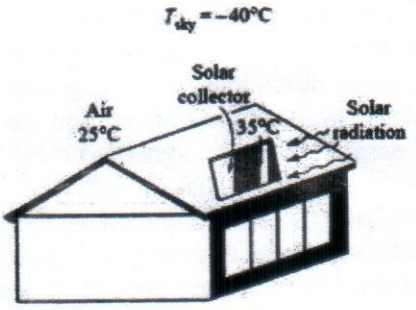

Figure 6

5 a) Show the development of the velocity boundary layer in a tube. **(05)**

b) Prove that in fully developed flow in a tube subjected to constant surface heat flux, the temperature gradient is independent of x and thus the shape of the temperature profile does not change along the tube. **(10)**

c) A computer cooled by a fan contains eight PCBs, each dissipating 10 W of power (as shown in **Fig 7**). The height of the PCBs is 12 cm and the length is 18 cm. The clearance between the tips of the components on the PCB and the back surface of the adjacent PCB is 0.3 cm. The cooling air is supplied by a 10-W fan mounted at the inlet. If the temperature rise of air as it flows through the case of the computer is not to exceed 10°C, determine (a) the flow rate of the air that the fan needs to deliver, (b) the fraction of the temperature rise of air that is due to the heat generated by the fan and its motor, and (c) the highest allowable inlet air temperature if the surface temperature of the components is not to exceed 70°C anywhere in the system. Use air properties at 25°C. **(10)**

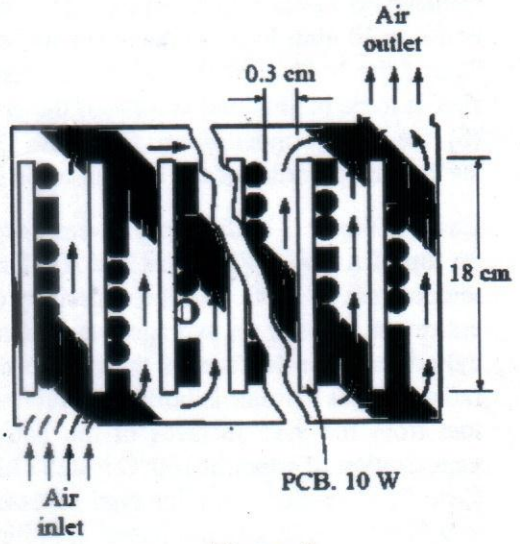

Figure 7

6 a) Define Penetration depth and Equimolar Counter diffusion in mass transfer? Show that the penetration depth is proportional to the square root of both the diffusion coefficient and time. **(10)**

b) Consider a shell-and-tube water-to-water heat exchanger with identical mass flow rates for both the hot and cold water streams. Now the mass flow rate of the cold water is reduced by half. Will the effectiveness of this heat exchanger increase, decrease, or remain the same as a result of this modification? Explain. Assume the overall heat transfer coefficient and the inlet temperatures remain the same. **(05)**

b) A vertical plate measuring 180 mm x 180 mm and at 50°C is exposed to atmosphere at 10°C (as shown in **Fig. 8**). Compare the free convection heat transfer from this plate with that which would result due to forced convection over the plate at a velocity equal to twice the maximum velocity which would occur in free convection boundary layer. The thermo-physical properties at film temperature are: k=0.02373 W/m°C, υ=16x10^{-6} m^2/s; Pr=0.701. **(10)**

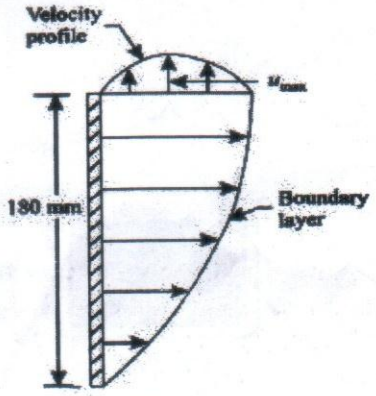

Figure 8

7. a) Classify Boiling heat transfer. Discuss about different boiling regimes and draw the typical boiling curve for water at 1 atm pressure. **(10)**

b) A thermosyphon consists of a closed container that absorbs heat along its boiling section and rejects heat along its condensation section (as shown in **Fig. 9**). Consider a thermosyphon made from a thin-walled mechanically polished stainless steel cylinder of diameter D. Heat supplied to the thermosyphon boils saturated water at atmospheric pressure on the surfaces of the lower boiling section of length L_b and is then rejected by condensing vapor into a thin film, which falls by gravity along the wall of the condensation section of length L_c back into the boiling section. The two sections are separated by an insulated section of length L_i. The top surface of the condensation section may be treated as being insulated. The thermosyphon dimensions are D = 20 mm, L_b = 20 mm, L_c = 40 mm, and L_i = 40 mm. Find (a) the mean surface temperature, $T_{s,b}$ of the boiling surface if the nucleate boiling heat flux is to be maintained at 30% of the critical heat flux, (b) the total condensation flow rate and the mean surface temperature of the condensation section, $T_{s,c}$. **(15)**

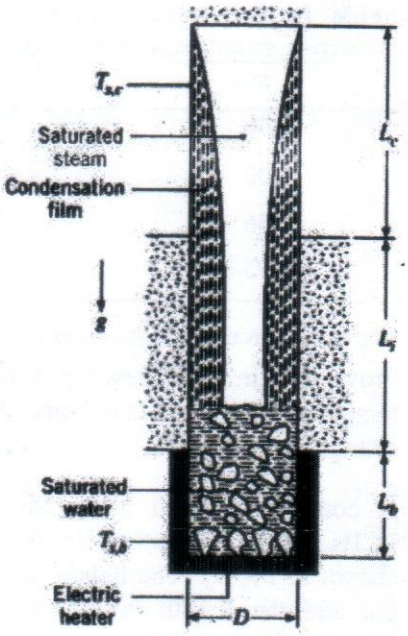

Figure 9

8. Case A: Water is boiling in a 12-cm-deep pan with an outer diameter of 25 cm that is placed on top of a stove (**Fig. 10**: Case A). The ambient air and the surrounding surfaces are at a temperature of 25°C, and the emissivity of the outer surface of the pan is 0.95. Assuming the entire pan to be at an average temperature of 98°C, determine the rate of heat loss from the cylindrical side surface of the pan to the surroundings by (a) natural convection and (b) radiation. (c) If water is boiling at a rate of 2.0 kg/h at 100°C, determine the ratio of the heat lost from the side surfaces of the pan to that by the evaporation of water. The heat of vaporization of water at 100°C is 2257 kJ/kg. **(25)**

Case B: Consider a similar type of case having a stainless steel spoon (k = 15.1 W/m°C, ε=0.6) that is partially immersed in boiling water at 95°C in a kitchen at 25°C (**Fig. 10**: Case B). The handle of the spoon has a cross section of about 0.2 cm x 1.0 cm and extends 18 cm in the air from the free surface of the water. The spoon loses heat by convection to the ambient air with an average heat transfer coefficient of h = 13 W/m^2 °C as well as by radiation to the surrounding surfaces at an average temperature of T_{surr}=295 K. Assuming steady one-dimensional heat transfer along the spoon and taking the nodal spacing to be 3 cm, (a) obtain the finite difference formulation for all nodes, (b) determine the temperature of the tip of the spoon by solving those equations, and (c) determine the rate of heat transfer from the exposed surfaces of the spoon.

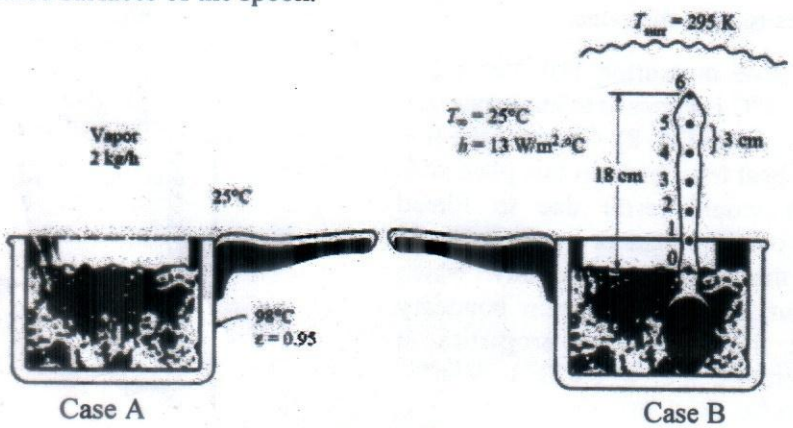

Figure 10

B.Sc. Engg. (ME)(8th Sem) 31 October 2018

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester, A.Y. 2017-2018
Course Code: MCE 4821 — Time : 3 hours
Course Title: Design for Manufacturing — Full Marks : 150

There are 8 (Eight) Questions. Answer any 6 (SIX) of them.

Marks in the Margin indicate the full marks.

1	a)	Define the term Design for Reliability and explain the different ways to improve reliability considering in design.	10
	b)	How reliability is measured? Explain the failure rate curve of parts using necessary schematic illustration.	10
	c)	How the levels of risk can be classified?	05
2	a)	Explain with schematic outline of Deming's chain reaction with respect to design for quality.	10
	b)	Explain briefly the different additional process improvement tools for design of quality improvement? Define the term "cost of quality".	15
3	a)	Write down in details the different steps that need to be followed to conduct a Failure Mode and Effect Analysis test.	15
	b)	Write down the different failure modes and hence explain the different failure analysis techniques?	10
4	a)	What are the goals of concurrent engineering? Why concurrent engineering is different from sequential engineering and hence show that concurrent engineering reduce time for product development?	10
	b)	Explain in details with necessary diagram the different systematic steps that need to be followed for Quality Function Deployment in product development.	15
5	a)	Define the term Design For Manufacture and Assembly (DFMA) and explain the different steps for the implementation of DFMA method in product design.	13
	b)	What is the meaning of Manufacturing cost and explain with block diagram the different elements of manufacturing cost and how it is estimated?	12
6	a)	Explain the term decomposition in physical domain and function domain with examples for product design purpose.	10
	b)	How the evaluations of the design concept are made and hence explain with example the Pugh's concept selection method?	15
7	a)	A sheet metal blank is 250 mm long and 175 mm wide and has semicircular ends with radius 80 mm. It is proposed that 500000 parts should be manufactured using 16 gage low carbon steel. Estimate the cost of the blanking die to produce the part and the percentage of scrap that would result from blanking operation. If the part were redesigned with 85 mm radius it could then be produced with a part off die. What would be die cost and percentage of manufactured scrap for this case?	18
	b)	Define the term Operational availability and Inherent availability	07
8	a)	What do you mean by knowledge engineering and how the knowledge is represented in DFMA system?	08
	b)	What is chaining in rule based expert system and hence defines the term forward chaining and backward chaining?	08
	c)	Explain with necessary diagram the problem solving strategies using knowledge engineering process for product design.	09

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ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester, A.Y. 2017-2018
Course No. MCE 4829 — TIME : 3 hours
Course Title: Industrial Management — Full Marks : 150

There are **8** (EIGHT) Questions. Answer any **6** (SIX) of them.
Marks in the Margin indicate the full marks. **Answer the questions with sufficient key points and/or arguments wherever necessary.**

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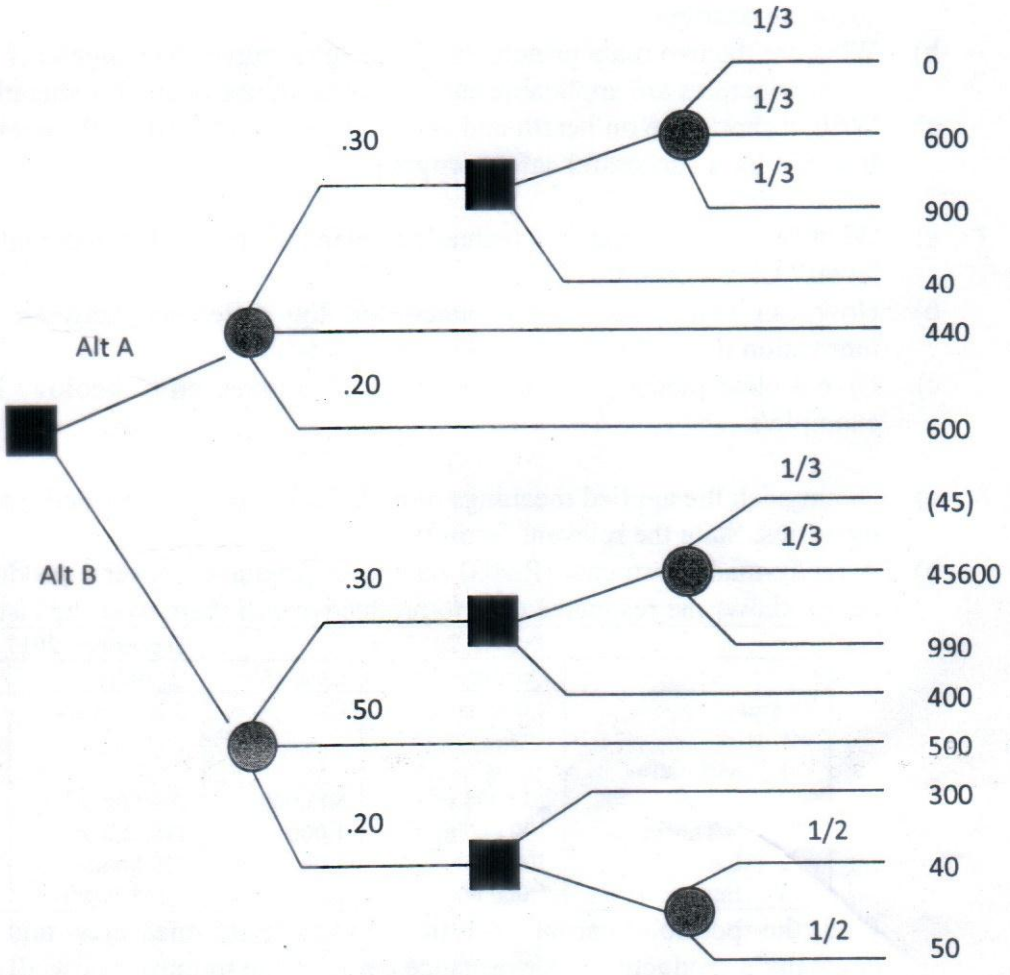
1 a) Being human as the best of creation we need to apply our thinking power to make our existence in this planet meaningful and beneficial for each other. Explain the statement from the contexts of our religion and the application of qualitative and quantitative decision-making techniques. 10

b) Pointing to the limitations of traditional technique, justify the exercise of brainstorming or nominal group technique in organizational decision-making. 5

c) Create a thinking map for IUT in order to become *a garden of knowledge and virtue* through quality education and research in engineering and technology for the Ummah and for humanity 10

2 a) In point form, write a short note of Delphi Technique in decision-making (its features and attributes). 10

b) Copy the following tree diagram in your answer booklet, write down the missing values and determine the alternative that has the higher/highest expected monetary value. Show all calculations and put the results on the diagram. 15



3 a) State the meaning and scope of job analysis in manufacturing/production. 5

b) Suppose you are given a responsibility in performing a job analysis. Systematically explain the steps you must follow in order to fulfill its purposes. 10

c) The management approach in a factory is to simplify jobs, make job rotations and enlargement and job enrichment. Explain vividly, why these things must be done. 10

4 a) For a comprehensive motivation, justify if both intrinsic and extrinsic types are inevitable. Give sufficient reasons. You can use any diagram/s. 8

b) Draw the necessary critical statements (in favor and against) on Frederick Taylor's piece rate incentive plan for increasing motivation. Cite an example. 7

c) Which of the following two theories are you going to apply in a factory producing automobile parts: Maslow's need hierarchy theory and Herzberg two-factor theory? Use the relevant diagrams and give reasons in support of your answer. 10

5 a) A new factory is going to produce ready-made garment (RMG) products. Will you suggest its management to use learning curves for its workers? What will be the possible learning effects? Also use diagram/s to illustrate your answer. 10

b) If unit 1 required 200 hours to produce and the labor records for a contract of 50 units indicate an average labor content of 63.1 hours per unit, what is the learning rate? What total additional man-hour would be required for additional 50 units? What would be the average labor content of this second contract? Of both contracts combined? If a labor costs the vendor of Tk100 per hour on this contract and the price to the buyer is a fixed Tk5000 each, what can you say about the profitability of the first and second contracts, and hence the bidding process in general? 15

6 a) A Former President of the American Management Association said that human resources development can be best discussed in terms of human development - philosophical, psychological, spiritual and physical. Explain his statement with adequate examples. 8

b) What are the two main principles of human resources management? Elaborate how these principles are applicable and should be in use in any organization. 7

c) Write a short note on health and safety of people at work with special reference to four E's for a successful safety program. 10

7 a) What do you understand by technology management both at national and enterprise levels? Give examples. 5

b) How can you make people understand the difference between creativity and innovation in a clear manner? Write adequately. 7

c) Give a clear picture, via statements and diagrams, on technology life cycle. Use example/s. 13

8 a) Distinguish the applied meanings of multifactor productivity and total productivity measures. State the relevant formulas. 10

b) A ready-made garments (RMG) factory is producing several products. The table below shows the resources used to produce one of them over the last two months. 15

	August, 2017		September, 2017	
	Quantity	Costs, $	Quantity	Costs, $
Output	2,000 units	-	2,2000 units	-
Inputs				
1. Material				
Cloth	200,000 m^2	600,000	200,000 m^2	600,000
Thread	100,000 m	1,000	110,000 m	1,100
2. Labor	500 hours	5,000	579 hours	5,790
3. Equipment	1,000 hours	7,500	1,158 hours	8565

Find the possible partial and total productivity measures and comment on company's productivity performance between the months. Show all calculations.

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B.Sc.Engg. (M)/4th Year / 31 October, 2018
BSc. TE(1year)2nd sem./BSc.TE(2year)4th sem.

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester, A.Y. 2017-2018
Course No. MCE 4839/MCE 4895 — TIME : 3.0 Hours
Course Title: Mechatronics — Full Marks : 150

There are 8 (Eight) Questions. Answer any 6(Six) Questions.
Marks in the margin indicate full marks.

1 a) What are the differences between ideal and practical current and voltage sources. How to convert a practical voltage sources to practical current sources and vice versa. (13)

b) For the circuit shown in Figure 1. what value of R_4 will balance the bridge (i.e. V_{ab} = 0) and at balanced condition , find the values of V_{ag} and V_{bg}. (12)

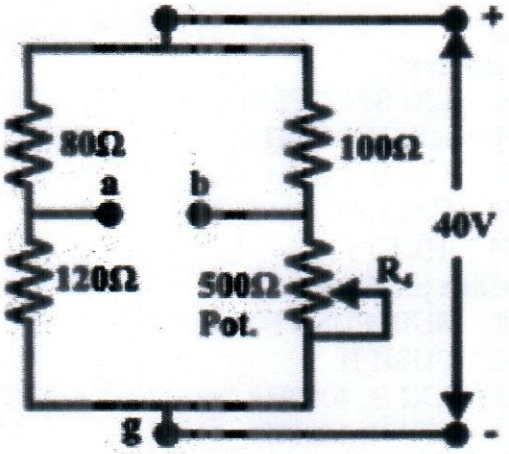

Figure 1

2 a) What are the steps of loop analysis of resistive circuit in the contest of DC voltages and currents. What are to be done if network contains both voltage and current sources. (13)

b) For the circuit shown in Figure 2. find the current through *'ab-branch'* (I_{ab}) and voltage (V_{cg}) across the current source using Node-voltage method. (12)

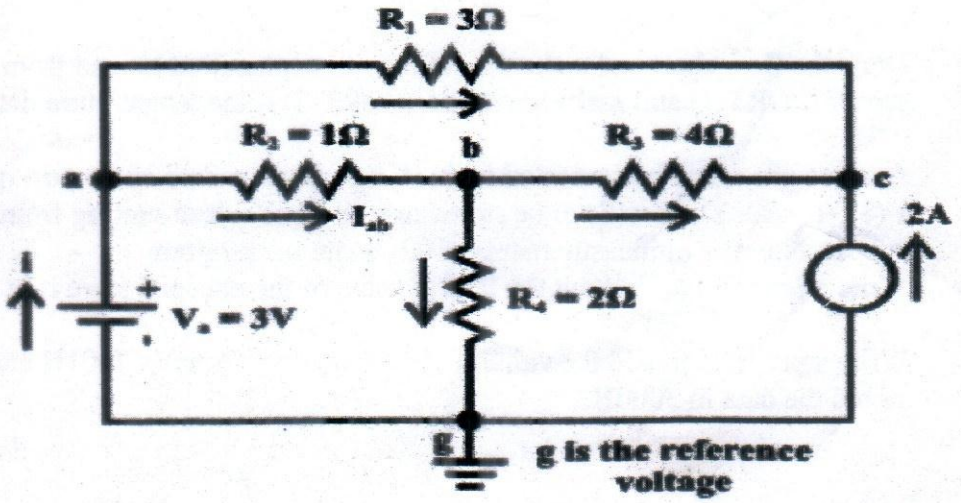

Figure 2

3 a) Describe the construction of a Transistor. What are the different types of transistor. (6)

b) Describe the working principle of NPN transistor works in a complete circuit. (5)

c) Describe Thevenin's and Norton's theorems in the context of DC voltage and current. What are the procedures for applying Thevenin's theorem. (14)

4 a) Why a signal conditioning element is needed in a control system? (3)

b) Describe the following amplifier along with the relations between the input and output.: Inverting amplifier, Non-inverting amplifier, Difference amplifier, Integrating amplifier, Differentiating amplifier and Logarithmic amplifier. (10)

c) Describe with the help of diagram the operation principle of a A/D flashback converter. (12)

5 a) Describe with sketches Von Neumann architecture of a microprocessor. Describe the structure and purposes of its elements. (12)

b) What are the common addressing modes of microprocessor 8085. Describe three of them. (13)

6 a) What we are the requirments for instruction set design? Classify the instructions. (7)

b) Explain the different data movement instructions used for microprocessor 8085. (18)

7 a) Read the program given below and state the contents of all registers (B,C,D,E,H,L and SP) after the execution of each instruction in sequence. (6)

```
1. Main program:
2. 4000H    LXI SP, 27FFH
3. 4003H    LXI H, 2000H
4. 4006H    LXI B, 1020H
5. 4009H    CALL SUB
6. 400CH    HLT
7. Subroutine program:
8. 4100H    SUB: PUSH B
9. 4101H    PUSH H
10. 4102H   LXI B, 4080H
11. 4105H   LXI H, 4090H
12. 4108H   SHLD 2200H
```

```
13. 4109H   DAD B
14. 410CH   POP H
15. 410DH   POP B
16. 410EH   RET
```

b) Draw the flow chart and write the codes with explanation to read from a temperature sensor (PORT-1) and make a relay on (PORT-2) if the temperature data is less than 07H. (19)

8 a) A micro processor is connected with a temperature sensor in the port named PORT-1 (8 bit data). The data is to be stored in memory devices starting from address 2000H. Number of measurement is 100. Write the program. (8)

b) Write a program to find out the largest value of the data and store it in 4000H. (9)

c) Write a program to add the value stored in memory location 2001H and 2006H and stored the data in 3000H. (8)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

SEMESTER FINAL EXAMINATION — SUMMER SEMESTER: 2017-2018

Course No: MCE-6119 — TIME : 03HRS

Course Name: Turbomachinery — FULL MARKS: 150

There are **EIGHT** Questions. Answer any **SIX** Questions.
Assume reasonable value for missing data. Figures in the margin indicate full marks.

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1. a) What do you mean by geometric, kinematic and dynamic similarity for the model and prototype? (10)

   b) Consider an axial flow pump, which has rotor diameter of 32 cm that discharges liquid water at the rate of 2.5m^3/min while running at 1450 rpm. The corresponding energy input is 120 J/kg, and the total efficiency is 78%. If a second geometrically similar pump with diameter of 22 cm operates at 2900 rpm, what are its (1) flow rate, (2) change in total pressure, and (3) input power? (15)

2. A centrifugal pump impeller has a diameter of 1.2 m; rpm 210; area at the outer periphery 0.65m^2; angle of vane at outlet 25^0, and ratio of external to internal diameter 2:1. Calculate (1) the hydraulic efficiency, (2) power, and (3) minimum speed to lift water against a head of 6.2 m. Assume that the pump discharges 1550 l/s (Fig. 01). (25)

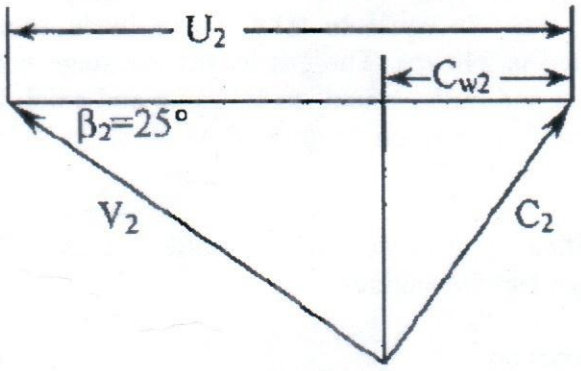

Figure: 01

3. A centrifugal pump impeller of 260mm diameter runs at 1400 rpm, and delivers 0.03 m^3/s of water. The impeller has a backward curved facing blades inclined at 30^0 to the tangent at outlet. The blades are 20 mm in depth at the outlet, and a slip factor of 0.78 may be assumed. Calculate the theoretical head developed by the impeller, and the number of impeller blades. (25)

4. A Pelton wheel is supplied with 0.035m^3/s of water under a head of 92 m. The (25)

wheel rotates at 725 rpm and the velocity coefficient of the nozzle is 0.95. The efficiency of the wheel is 82% and the ratio of bucket speed to jet speed is 0.45. Determine the following:

a. Speed of the wheel
b. Wheel to jet diameter ratio
c. Dimensionless power specific speed of the wheel

5. An inward flow turbine is supplied with 245 L of water per second and works under a total head of 30 m. The velocity of wheel periphery at inlet is 16 m/s. The outlet pipe of the turbine is 28 cm in diameter. The radial velocity is constant. Neglecting friction, calculate (25)

a. The vane angle at inlet
b. The guide blade angle
c. Power.

6. (a) What do you mean by degree of reaction of a gas turbine engine? Derive an expression for such in light of velocity triangles of the turbine stage. (10)

(b) In a single-stage axial flow gas turbine gas enters at stagnation temperature of 1100K and stagnation pressure of 5 bar. Axial velocity is constant through the stage and equal to 250 m/s. Mean blade speed is 350 m/s. Mass flow rate of gas is 15 kg/s and assume equal inlet and outlet velocities. Nozzle efflux angle is 63^0, stage exit swirl angle equal to 9^0. Determine the rotor blade gas angles, degree of reaction, and power output. (15)

7. In a single-stage axial flow gas turbine, gas enters the turbine at a stagnation temperature and pressure of 1150K and 8 bar, respectively. Isentropic efficiency of stage is equal to 0.88, mean blade speed is 300 m/s, and rotational speed is 240 rps. The gas leaves the stage with velocity 390 m/s. Assuming inlet and outlet velocities are same and axial, find the blade height at the outlet conditions when the mass flow of gas is 34 kg/s, and temperature drop in the stage is 145 K. (25)

8. (a) Explain significance of blade loading coefficient and flow coefficient in the design axial gas turbine engines. (10)

(b) Write short notes on: (15)

(i) Hydraulic turbine Losses.
(ii) Pump cavitations.
(iii)Hydraulic pump slip factor.

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MSc.TE (2-Yr)2nd Semester **23 October 2018 (Morning)**

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester, A.Y. 2017-2018
Course Code: MCE 6291 — Time : 3 hours
Course Title: Thermal Environmental Engineering — Full Marks : 150

There are **8 (eight)** Questions. Answer any **6 (six)** of them.
Figures in the Margin indicate the full marks. The symbols have their usual meaning.

1. a) Differentiate between a heat engine, refrigerator and a heat pump and establish the following relationship: 13

$$(COP)_{hp} = (COP)_{ref} + 1$$

   b) A machine working on a Carnot cycle operates between 305 K and 260 K. Determine the COP when it is operated as (i) a refrigerating machine; (ii) a heat pump; and (iii) a heat engine. 12

2. a) Explain the mechanism of a simple vapour compression refrigeration system with schematic diagram. 17

   b) Write down the advantages and disadvantages of vapour compression refrigeration system over air refrigeration system. 8

3. a) Write down the desirable properties of an ideal refrigerant. 8

   b) Write down the number of refrigerant of Dichloro-trifluoro-ethane. 6

   c) Briefly explain how the secondary refrigerant works with the system. Write down some desirable properties of the secondary refrigerant. 11

4. a) Write down the advantages of compound vapour compression refrigeration system with intercooler. 8

   b) Explain the mechanism of a two stage compression refrigeration system with liquid intercooler. Draw the schematic diagram of the system. 17

5. With the help of neat sketch explain the mechanism of a practical vapour absorption system. 25

6. a) Write down the merits and demerits of air refrigeration system. 7

   b) With the help of neat sketch, explain the mechanism of a simple air cooling system. 18

7. a) Classify refrigerant compressors according to different ways. 11

   b) Write down the advantages and disadvantages of centrifugal compressors over 14

reciprocating compressors.

8. a) Explain different factors affecting condenser capacity. 10

b) Compare between air-cooled and water-cooled condensers. 15

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M.Sc. Engg. / Ph.D. (M) October 26, 2018

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester, A. Y. 2016-2017
Course No.: MCE 6421 — Time: 3 Hours 00 Min(s)
Course Title: Robotics and Manufacturing Automation — Full Marks: 150

There are 8 (Eight) questions. Answer any 6 (Six) questions.

Marks in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper.

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1. a) What is automation? What is the difference between a process parameter and a process variable? 13
   b) Identify the five levels of automation in a production plant. Explain them briefly. 12

2. a) Using the notation scheme for defining manipulator configurations, draw diagrams of the following robots: (a) TRT:R, (b) TVR:TR, (c) RR:T. 13
   b) What is the difference between repeatability and accuracy in a robotic manipulator? 12

3. a) In a machine loading and unloading application, what is the advantage of a dual gripper over a single gripper? 13
   b) In automated guided vehicle systems, how the vehicle management system works? 12

4. a) What is adaptive control? What are the three functions of adaptive control? 13
   b) What is supervisory control? Explain its working steps. 12

5. a) A temperature sensor has a measurement range of -15°C to 110°C. 13
   The output range is -5.0 to +5.0 mv. It has a resolution of 0.5°C.
   i) Determine the number of bits in ADC?
   ii) What is the reading of the ADC when the output of the sensor is 2.5 mv?
   b) For 3.8 V, calculate is the digital output by using a Successive-Approximation ADC method? Also calculate the error. (8-bit A/D with range 0V – 5V) 12

6. a) Name and explain the four tests of flexibility that a manufacturing system must satisfy in order to be classified as flexible. 13
   b) What is the difference between the primary and secondary handling systems that are common in flexible manufacturing systems? 12

7. a) What is a flexible manufacturing cell and a flexible manufacturing system? What is the dividing line between these two, in terms of the number of workstations in the system? 13
   b) What are the different FMS Operational Issues? Explain them briefly. 12

8. a) What are the five categories of material transport equipment commonly used to move parts and materials inside a facility? Explain them briefly. 13

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b) An overhead trolley conveyor is configured as a continuous closed loop. The delivery loop has a length of 150 m and the return loop = 130 m. All parts loaded at the load station are unloaded at the unload station. Each hook on the conveyor can hold one part and the hooks are separated by 4 m. Conveyor speed = 1.75 m/s. Determine (i) Maximum number of parts in the conveyor system, (ii) Parts flow rate; and (iii) Maximum loading and unloading times that are compatible with the operation of the conveyor system? 12

MSc TE (MCE)/4th Sem

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22 October 2018

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester, A.Y. 2017-2018
Course Code: MCE 6497 — Time : 3 hours
Course Title: Engineering Economics — Full Marks : 150

There are 8 (Eight) Questions. Answer any 6 (Six) of them.

Assume reasonable value if required. Figures in the Margin indicate the full marks.

1. a) Derive the following equation where symbols have their usual meanings 5

$F = P(1+i)^n$

b) What is the main difference of Islamic Insurance(Takaful) with the conventional Insurance? Describe two main types of Takaful products with numeric examples 10

c) Write down four main differences between Islamic and Conventional Banking. Describe Bai Muazzal mode of loan with a numerical example. 10

2. a) A company that manufactures pumps is trying to decide between the machines shown below. Compare them on the basis of their Present Worth(PW) values, using an interest rate of 12% per year 20

	Machine A	Machine B
First cost, $	370,000	320,000
Annual Operating Cost,$/year	200,000	300,000
Onetime overhauling cost in year 3, $	Not Applicable	26,000
Onetime overhauling cost in year 2, $	140,000	Not Applicable
Servicing cost, $	$ 400 at year 2 and then increases by $50 every year	$ 200 at year 3 and then increases by 2% every year
Salvage value	19,000	30,000
Life, years	6	9

b) Describe MARR with an example. 5

3. a) Compare the alternatives shown below on the basis of their Present Worth(PW) over the planning horizon of 5 years, using an interest rate of 12% per year and provide a decision about which one of them should be selected. 20

Item	Project X	Project Y	Project Z
Initial Cost, $	250,000	100,000	300,000
Annual operating cost, $/year	130,000	65,000	Not Applicable
Maintenance Cost,$	$ 26000 at year 2,then increases by$2000 every year	Not Applicable	$ 31000 at year 3,then increases by 4% every year
Annual Revenue, $/year	400,000	270,000	370,000
Painting cost in 3rd year,$	20,000	Not applicable	15,000
Salvage value, $	Not applicable	70,000	100,000
Life, years	3	4	6

b) Describe any one method of pricing with an example. . 5

4. a) PTX Industry is considering three machines to use in the production line. Which machine should be selected on the basis of Annual Worth(AW) analysis at an interest rate of 12% per year? 15

Item	Machine P	Machine Q	Machine R
Initial Cost, $	200,000	235,000	195,000
Maintenance Cost, $	$ 29,000 at year 4,then increases by 3% every year	$ 27,000 at year 2,then increases by $2100 every year	$20,000 every year
Annual income, $/year	140,000	150,000	250,000
One time overhauling cost at year 3	Not applicable	$ 9,500	$2,000
Salvage value, $	Not Applicable	25,000	80,000
Life, years	10	5	6

b) Select appropriate bundle of proposals, if any, using capital budgeting method. Here MARR is 12% per year and available capital budget is $17500. 10

		Net Cash Flow(NCF), $				
Proposal	Initial Investment, $	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
P1	9000	1000	1700	2400	3100	3800
P2	10000	500	600	700	800	10500
P3	8000	5000	5000	2000		
P4	9000	0	0	0	15000	

5. a) A store sells a certain brand of Drill Jig which has the following characteristics: 20
Average annual sales = 500 units
Ordering cost = 35 dollar per order, Carrying interest rate = 15% per year
Item cost = 300 dollar per unit, Lead time = 6 days
Standard deviation of daily demand = 0.1 unit
Working days per year = 290
i) Determine the Economic Order Quantity(EOQ)
ii) Calculate the Reorder point (R) for a 85 percent service level
iii) State the Q rule(continuous review system) for this item.
iv) Determine Target Inventory (T) and Period (P) for P (Periodic review) system of inventory for 90% service level.
v) State P rule (Periodic review system) for this item.

b) Find 4-weeks moving average forecasts for demand from the following table. 5

Week	Demand
week 1	568
week 2	625
week 3	758
week 4	839
week 5	658
week 6	852
week 7	933

6. a) A company that manufactures magnetic membrane switches is investigating three production options that have the estimated cash flows below. Determine the which option is preferable at an interest rate of 12% per year using Annual Worth(AW) method. All values are in millions. 15

	In house	License	Contract
Initial Cost, $	30	2	0
Annual cost, $/year	5	0.2	2
Annual income, $/year	14	1.5	2.5
Salvage value, $	7	0	0
Life, years	10	infinity	5

b) KTL enterprises constructed an addition to its building at a cost of $70,000. Extra annual expenses are expected to be $1850, but extra income will be $14,000 per year. There is a one time registration fee of $300 to be paid at year 2. Find out the pay back period at an interest rate of 12% per year 10

7. a) Newport Mining Company has purchased a computer controlled gold ornaments manufacturing unit for $80,000. The unit has an anticipated life of 5 years and a salvage value of $10000. Use Straight Line depreciation method to find out schedule of depreciation and book value for each year and present in a table 10

b) Bio Health, a bio device systems leasing company, is considering a new equipment purchase to replace a currently owned asset that was purchased 2 years ago for $250,000. It is appraised at a current market value of only $50,000. An upgrade is possible for $200,000 now that would be adequate for another 3 years of lease rights, after which the entire system could be sold on the international circuit for an estimated $40,000. The challenger can be purchased at a cost of $300,000, has an expected life of 10 years, and has a $50,000 salvage value. Determine whether the company should upgrade or replace at a MARR of 12% per year. Assume the AOC estimates are the same for both alternatives. 15

8. a) How much money would be in the account of a person who deposited $1000 now and $100 every month and withdrew $100 every 2 months for 3 years? Use an interest rate of 11.66% per year compounded half yearly with no interperiod interest paid. Use the closest interest rate provided in the factor table after getting effective rate. 15

b) Derive the equation for pay back quantity. BIGS Corporation assembles 30 trucks per year. Find out the current break even quantity from the following information is available: 10
Fixed cost : $ 800,000 Pay Back Period: 4 years
Variable cost per unit: $35000
Revenue per unit: $75000

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Formula:

Geometric gradient:

$$(P/A,g,i,n) = \frac{1-\left(\frac{1+g}{1+i}\right)^n}{i-g} \quad \text{when } g \neq i \quad \text{and} \quad \frac{n}{1+i} \quad \text{when } g = i$$

z	Service Level, percent	Stockout, percent
0	50	50
0.5	69.1	30.9
1	84.1	15.9
1.1	86.4	13.6
1.2	88.5	11.5
1.3	90.3	9.7
1.4	91.9	8.1
1.5	93.3	6.7
1.6	94.5	5.5
1.7	95.5	4.5
1.8	96.4	3.6

Normal Demand Percentages

12% Compound Interest Factors 12%

n	Single Payment: Compound Amount Factor — Find F Given P F/P	Single Payment: Present Worth Factor — Find P Given F P/F	Uniform Payment Series: Sinking Fund Factor — Find A Given F A/F	Uniform Payment Series: Capital Recovery Factor — Find A Given P A/P	Uniform Payment Series: Compound Amount Factor — Find F Given A F/A	Uniform Payment Series: Present Worth Factor — Find P Given A P/A	Arithmetic Gradient: Gradient Uniform Series — Find A Given G A/G	Arithmetic Gradient: Gradient Present Worth — Find P Given G P/G	n
1	1.120	.8929	1.0000	1.1200	1.000	0.893	0	0	1
2	1.254	.7972	.4717	.5917	2.120	1.690	0.472	0.797	2
3	1.405	.7118	.2963	.4163	3.374	2.402	0.925	2.221	3
4	1.574	.6355	.2092	.3292	4.779	3.037	1.359	4.127	4
5	1.762	.5674	.1574	.2774	6.353	3.605	1.775	6.397	5
6	1.974	.5066	.1232	.2432	8.115	4.111	2.172	8.930	6
7	2.211	.4523	.0991	.2191	10.089	4.564	2.551	11.644	7
8	2.476	.4039	.0813	.2013	12.300	4.968	2.913	14.471	8
9	2.773	.3606	.0677	.1877	14.776	5.328	3.257	17.356	9
10	3.106	.3220	.0570	.1770	17.549	5.650	3.585	20.254	10
11	3.479	.2875	.0484	.1684	20.655	5.938	3.895	23.129	11
12	3.896	.2567	.0414	.1614	24.133	6.194	4.190	25.952	12
13	4.363	.2292	.0357	.1557	28.029	6.424	4.468	28.702	13
14	4.887	.2046	.0309	.1509	32.393	6.628	4.732	31.362	14
15	5.474	.1827	.0268	.1468	37.280	6.811	4.980	33.920	15
16	6.130	.1631	.0234	.1434	42.753	6.974	5.215	36.367	16
17	6.866	.1456	.0205	.1405	48.884	7.120	5.435	38.697	17
18	7.690	.1300	.0179	.1379	55.750	7.250	5.643	40.908	18
19	8.613	.1161	.0158	.1358	63.440	7.366	5.838	42.998	19
20	9.646	.1037	.0139	.1339	72.052	7.469	6.020	44.968	20
21	10.804	.0926	.0122	.1322	81.699	7.562	6.191	46.819	21
22	12.100	.0826	.0108	.1308	92.503	7.645	6.351	48.554	22
23	13.552	.0738	.00956	.1296	104.603	7.718	6.501	50.178	23
24	15.179	.0659	.00846	.1285	118.155	7.784	6.641	51.693	24
25	17.000	.0588	.00750	.1275	133.334	7.843	6.771	53.105	25
26	19.040	.0525	.00665	.1267	150.334	7.896	6.892	54.418	26
27	21.325	.0469	.00590	.1259	169.374	7.943	7.005	55.637	27
28	23.884	.0419	.00524	.1252	190.699	7.984	7.110	56.767	28
29	26.750	.0374	.00466	.1247	214.583	8.022	7.207	57.814	29
30	29.960	.0334	.00414	.1241	241.333	8.055	7.297	58.782	30
31	33.555	.0298	.00369	.1237	271.293	8.085	7.381	59.676	31
32	37.582	.0266	.00328	.1233	304.848	8.112	7.459	60.501	32
33	42.092	.0238	.00292	.1229	342.429	8.135	7.530	61.261	33
34	47.143	.0212	.00260	.1226	384.521	8.157	7.596	61.961	34
35	52.800	.0189	.00232	.1223	431.663	8.176	7.658	62.605	35
40	93.051	.0107	.00130	.1213	767.091	8.244	7.899	65.116	40
45	163.988	.00610	.00074	.1207	1 358.2	8.283	8.057	66.734	45
50	289.002	.00346	.00042	.1204	2 400.0	8.304	8.160	67.762	50
55	509.321	.00196	.00024	.1202	4 236.0	8.317	8.225	68.408	55
60	897.597	.00111	.00013	.1201	7 471.6	8.324	8.266	68.810	60
65	1 581.9	.00063	.00008	.1201	13 173.9	8.328	8.292	69.058	65
70	2 787.8	.00036	.00004	.1200	23 223.3	8.330	8.308	69.210	70
75	4 913.1	.00020	.00002	.1200	40 933.8	8.332	8.318	69.303	75
80	8 658.5	.00012	.00001	.1200	72 145.7	8.332	8.324	69.359	80
85	15 259.2	.00007	.00001	.1200	127 151.7	8.333	8.328	69.393	85
90	26 891.9	.00004		.1200	224 091.1	8.333	8.330	69.414	90
95	47 392.8	.00002		.1200	394 931.4	8.333	8.331	69.426	95
100	83 522.3	.00001		.1200	696 010.5	8.333	8.332	69.434	100

15% Compound Interest Factors 15%

n	Single Payment: Compound Amount Factor — Find F Given P F/P	Single Payment: Present Worth Factor — Find P Given F P/F	Uniform Payment Series: Sinking Fund Factor — Find A Given F A/F	Uniform Payment Series: Capital Recovery Factor — Find A Given P A/P	Uniform Payment Series: Compound Amount Factor — Find F Given A F/A	Uniform Payment Series: Present Worth Factor — Find P Given A P/A	Arithmetic Gradient: Gradient Uniform Series — Find A Given G A/G	Arithmetic Gradient: Gradient Present Worth — Find P Given G P/G	n
1	1.150	.8696	1.0000	1.1500	1.000	0.870	0	0	1
2	1.322	.7561	.4651	.6151	2.150	1.626	0.465	0.756	2
3	1.521	.6575	.2880	.4380	3.472	2.283	0.907	2.071	3
4	1.749	.5718	.2003	.3503	4.993	2.855	1.326	3.786	4
5	2.011	.4972	.1483	.2983	6.742	3.352	1.723	5.775	5
6	2.313	.4323	.1142	.2642	8.754	3.784	2.097	7.937	6
7	2.660	.3759	.0904	.2404	11.067	4.160	2.450	10.192	7
8	3.059	.3269	.0729	.2229	13.727	4.487	2.781	12.481	8
9	3.518	.2843	.0596	.2096	16.786	4.772	3.092	14.755	9
10	4.046	.2472	.0493	.1993	20.304	5.019	3.383	16.979	10
11	4.652	.2149	.0411	.1911	24.349	5.234	3.655	19.129	11
12	5.350	.1869	.0345	.1845	29.002	5.421	3.908	21.185	12
13	6.153	.1625	.0291	.1791	34.352	5.583	4.144	23.135	13
14	7.076	.1413	.0247	.1747	40.505	5.724	4.362	24.972	14
15	8.137	.1229	.0210	.1710	47.580	5.847	4.565	26.693	15
16	9.358	.1069	.0179	.1679	55.717	5.954	4.752	28.296	16
17	10.761	.0929	.0154	.1654	65.075	6.047	4.925	29.783	17
18	12.375	.0808	.0132	.1632	75.836	6.128	5.084	31.156	18
19	14.232	.0703	.0113	.1613	88.212	6.198	5.231	32.421	19
20	16.367	.0611	.00976	.1598	102.444	6.259	5.365	33.582	20
21	18.822	.0531	.00842	.1584	118.810	6.312	5.488	34.645	21
22	21.645	.0462	.00727	.1573	137.632	6.359	5.601	35.615	22
23	24.891	.0402	.00628	.1563	159.276	6.399	5.704	36.499	23
24	28.625	.0349	.00543	.1554	184.168	6.434	5.798	37.302	24
25	32.919	.0304	.00470	.1547	212.793	6.464	5.883	38.031	25
26	37.857	.0264	.00407	.1541	245.712	6.491	5.961	38.692	26
27	43.535	.0230	.00353	.1535	283.569	6.514	6.032	39.289	27
28	50.066	.0200	.00306	.1531	327.104	6.534	6.096	39.828	28
29	57.575	.0174	.00265	.1527	377.170	6.551	6.154	40.315	29
30	66.212	.0151	.00230	.1523	434.745	6.566	6.207	40.753	30
31	76.144	.0131	.00200	.1520	500.957	6.579	6.254	41.147	31
32	87.565	.0114	.00173	.1517	577.100	6.591	6.297	41.501	32
33	100.700	.00993	.00150	.1515	664.666	6.600	6.336	41.818	33
34	115.805	.00864	.00131	.1513	765.365	6.609	6.371	42.103	34
35	133.176	.00751	.00113	.1511	881.170	6.617	6.402	42.359	35
40	267.864	.00373	.00056	.1506	1 779.1	6.642	6.517	43.283	40
45	538.769	.00186	.00028	.1503	3 585.1	6.654	6.583	43.805	45
50	1 083.7	.00092	.00014	.1501	7 217.7	6.661	6.620	44.096	50
55	2 179.6	.00046	.00007	.1501	14 524.1	6.664	6.641	44.256	55
60	4 384.0	.00023	.00003	.1500	29 220.0	6.665	6.653	44.343	60
65	8 817.8	.00011	.00002	.1500	58 778.6	6.666	6.659	44.390	65
70	17 735.7	.00006	.00001	.1500	118 231.5	6.666	6.663	44.416	70
75	35 672.9	.00003		.1500	237 812.5	6.666	6.665	44.429	75
80	71 750.9	.00001		.1500	478 332.6	6.667	6.666	44.436	80
85	144 316.7	.00001		.1500	962 104.4	6.667	6.666	44.440	85