B Sc. Eng. (ME)(2nd Semester) 24 October, 2019

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

Final Semester Examination — Summer Semester, A.Y. 2018-2019
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) Consider an electric circuit containing a capacitor, resistor, and battery shown in figure Q1(a). The charge Q(t) on the capacitor satisfies the equation $R\frac{dQ}{dt}+\frac{Q}{C}=V$, where R is the resistance, C is the capacitance, and V is the constant voltage supplied by the battery.

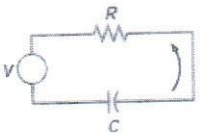


Fig.: Q1(a)

(i) If $Q(0) = 0$, find $Q(t)$ at any time t, and sketch the graph of Q versus t.
(ii) Find the limiting value Q_L that $Q(t)$ approaches after a long time.
(iii) Suppose that $Q(t_1) = Q_L$ and that the battery is removed from the circuit at $t = t_1$. Find $Q(t)$ for $t > t_1$ and sketch its graph.

b) A tank originally contains 100 gal of fresh water. Then water containing $\frac{1}{2}$ lb of salt per gallon is poured into the tank at a rate of 2 gal/min, and the mixture is allowed to leave at the same rate. After 10 min the process is stopped, and fresh water is poured into the tank at a rate of 2 gal/min, with the mixture again leaving at the same rate.
Find the amount of salt in the tank at the end of an additional 10 min.

2. a) (i) Find the solution of the following initial value problem.
(ii) Sketch the graph of the solution in part 2a(i) and describe its behavior for increasing t.

$$16y''-8y'+145y=0;y(0)=-2;y'(0)=1$$

b) Determine the general solution of the differential equation given bellow:

$$y^{iv}+2y''+y=3\sin t-5\cos t$$

3. a) Find the Wronskian of two solutions of the following differential equation without solving the equation: $x^2y''+xy'+\left(x^2-v^2\right)y=0$

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,
(i) Formulate the initial value problem that governs the motion of the mass.
(ii) Determine the expression of the position of the mass at any later time.
(iii) Also determine the period, amplitude, and phase of the motion.

4. (i) Find the interval and radius of convergence for $\sum_{n=1}^{\infty}\frac{(x-3)^n}{2^n n}$

(ii) Use the power series method to solve the following initial-value problem:

$$(x+1)y''-(2-x)y'+y=0,\ y(0)=2,\ y'(0)=-1$$

(iii) Determine and classify the singular points of the following differential equation:

$$\left(x^2-4\right)^2y''+3(x-2)y'+5y=0$$

5. (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.
(iii) 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.

6. a) Find the inverse Laplace transform of

$$(i)\ \frac{s^2+6s+9}{(s-1)(s-2)(s+4)} \qquad (ii)\ \frac{2s-4}{(s^2+s)(s^2+1)}$$

b) Using Laplace Transformation solve the following initial value problem:

$$y''-3y'+2y=e^{-4t};y(0)=1;y'(0)=5$$

7. a) (i) State convolution theorem for laplace transformation.
(ii) Use Convolution theorem to compute

$$L^{-1}\left\{\frac{1}{s^2(s-1)}\right\}$$

(iii) Compute the Laplace Transformation of the following triangular wave function shown in figure Q 7(a_iii)

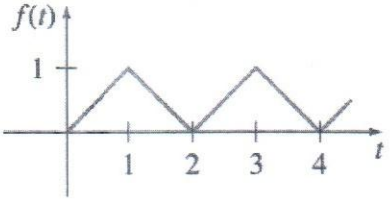


Fig.: Q7 (a_iii)

b) A block is attached to a massless spring of spring and they are placed on a horizontal and perfectly smooth bench descrived in the figure Q 7(b). We add a force $f(t)=\cos 4t$ to the block during $t\in[0,2\pi]$ and remove it at all other times (the spring is still there). The Equation of motion of the block is

$$\begin{cases} x''+16x=\cos 4t \\ x(0)=0 \\ x'(0)=1 \end{cases}$$

Use Laplace Transformation find the genaral solution of the equation.

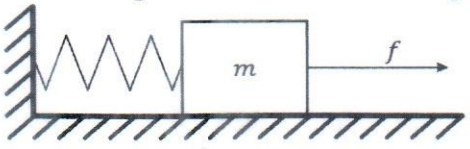


Fig.: Q 7(b)

8. 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 $t = 0$.

(i) Write down the appropriate partial differential equation for y (x, t) with initial and boundary conditions, where x is the displacement of any point from one end at time t.
(ii) Solve the differential equation in (i) using method of separation of variables.

B.Sc. Engg.(M)/2nd Sem. 28 October, 2019

ISLAMIC UNIVERSITY OF TECHNOLOGY

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination — Summer Semester 2018-2019
Course No. Phy 4213 — Time: 3.00 HRS.
Course Title: Waves & Oscillations, Geometrical Optics and Wave Mechanics — Full Marks: 150

There are **EIGHT** Questions. Answer any **SIX** Questions
Marks in the margin indicate full marks
Programmable calculators are not allowed. Do not write on this question paper.

1. (a) What are the different characteristics of simple harmonic motion (SHM)? Obtain the differential equation of motion of a particle executing SHM and hence solve it to find the displacement of the particle. 18

   (b) The displacement of an oscillating particle at an instant t is given by $A\cos \omega t + B\sin \omega t$. If $A = 1.0$ m, $B = 1.2$ m and $\omega = 5$ radian/sec., calculate i) the amplitude, ii) the time period, iii) the maximum velocity and iv) the maximum acceleration of the particle. 7

2. (a) Explain forced vibration. Establish the differential equation of motion for a particle executing forced vibration which is subjected to an external periodic force. Write down the solution of this equation and explain its significance. 18

   (b) Define resonance. Discuss sharpness of resonance. 7

3. (a) What is Doppler's effect in sound? Deduce the expressions for the apparent frequency of the note when the source and the observer are (i) moving towards each other and (ii) moving away from each other. 18

   (b) Two aeroplanes pass each other. One of these is blowing a whistle of frequency 500 Hz. Calculate the frequencies of the notes heard in the other aeroplane (i) before and (ii) after they have crossed each other.(Velocity of sound =330 m/s and velocity of either of the aeroplanes = 600 km/hr.) 7

4. (a) Two thin convex lenses of focal lengths f_1 and f_2 are placed coaxially in air a certain distance d apart. Show that the equivalent focal length f of the equivalent lens of the combination is given by $f = f_1 f_2/(f_1 + f_2 - d)$. 18

   (b) A thin convex lens of focal length 25 cm is placed coaxially with another thin convex lens of focal length 20 cm at a distance of 15 cm from each other. Find the equivalent focal length and the positions of the principal points of the combination. 7

5. (a) Explain with suitable diagram, what do you understand by spherical aberration. Discuss the simple methods of correction of spherical aberration in case of an ordinary lens. 18

(b) Write in brief about a polarizing microscope. 7

6. (a) What do understand by the term expectation value? Derive the time dependent Schrodinger equation. 18

(b) Write down the Schrodinger equation of a particle in one dimensional box and solve it to calculate the values of the energy of the particle. 7

7. (a) State the Fermi-Dirac distribution law. Obtain the expression for the energy density for a photon gas (blackbody radiation) of wavelength, λ using Bose-Einstein distribution law. 18

(b) Write down the differences between classical and quantum statistics. 7

8. Answer the followings: (25/4x4 =25)

(a) Distinguish between standing waves and travelling waves

(b) Achromatism

(c) Fundamental postulates of statistical mechanics

(d) Eigenfunction and Eigenvalue

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

Semester Final Examination — Summer Semester, A.Y. 2018-2019
Course Code: Chem 4215 — Time : 3.0 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) Discuss Clark process and Lime-Soda process for the removing of water hardness. **5**

b) Distinguish between scale and sludge. Write the reaction involved in the formation of sludge and scale in the boiler. What are the reasons for the formation of sludge and scale? How formation of scale and sludge can be prevented? **8**

c) A Zeolite softener was completely exhausted by the treatment of water. It was then regenerated by passing 800 litres of NaCl solution containing 75 g per litre NaCl. Calculate the amount (in litre) of sample water of hardness 250 ppm that can be softened by this softener. **$3\frac{2}{3}$**

2 a) How can underwater corrosion be classified depending on the quality of water? **4**

b) Discuss the effect of different factors on the rate of under-water corrosion. **7**

c) Write different methods for the prevention of corrosion. Discuss any method them. **$5\frac{2}{3}$**

3 a) Discuss the different steps with block diagram involved in the manufacturing of Portland cement. **$8\frac{2}{3}$**

b) Discuss the theories of setting and hardening of cement with chemical reactions involved. **8**

4 a) What is glass? Describe the physical and chemical properties of glass. **4**

b) Write down the reactions involved during manufacturing of glass when the batch material contains (i) soda, limestone and silica (ii) red lead, K_2CO_3 and silica. **$6\frac{2}{3}$**

c) Write notes on the following terms: **6**
(i) Borosilicate glass (ii) Tempered glass (iii) Soda lime glass

5 a) Write notes on the preparation, properties and uses of the following: 6
(i) Nylon 66 (ii) Bakelite (iii) Melamine

b) What is HDPE? Explains the properties and uses of HDPE. Discuss the mechanism for the preparation of HDPE. $5\frac{2}{3}$

c) What are the ingredients used in polymers processing? Briefly discuss their function. 5

6 a) Write a brief description about clay, sand and feldspar as a raw materials of ceramic wares 6

b) Write down the different chemical conversion that take place during firing of ceramic ware. 5

c) Write notes on the following terms: $5\frac{2}{3}$
(i) Terra cotta (ii) Porcelain (iii) Enamel

7 a) What is rubber? Mention its important properties that make it suitable for the manufacture of valuable goods. 4

b) How can you prove that following characteristic of rubber? 6
(i) Rubber is a hydrocarbon (ii) Rubber is unsaturated hydrocarbon (iii) Rubber is a polymer of isoprene monomer and (iv) Rubber is a cis-polymer of isoprene unit.

c) What do you understand by compounding? What are the substances used in compounding? Mention their specific functions. $6\frac{2}{3}$

8 a) What is grease? How it is prepared? What is the advantage and disadvantage of grease as a lubricant? $5\frac{2}{3}$

b) Write notes on the following terms: 6
(i) Spalling (ii) Thermal conductivity (iii) Porosity

c) Classify refractory materials 5

Programme: BScTE (1-Year 2nd Sem, 2-Year 4th Semester) **Date**: Tuesday, 29 October 2019

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF TECHNICAL AND VOCATIONAL EDUCATION (TVE)

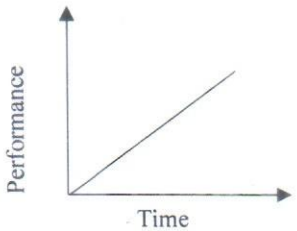
Semester Final Examination — Summer Semester (2018-2019)
Course No: TVE 4237 — Time: 3.00 hours
Course Title: Educational Measurement and Statistics — Full Marks: 150

There are eight (8) questions. Answer any six (6).
Figures in the right margin indicate marks of the questions.

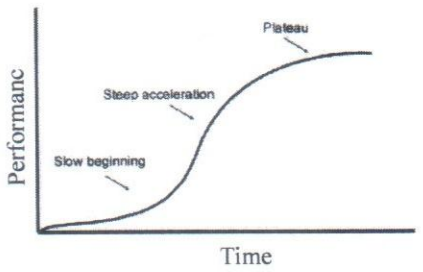
1. a) Define assessment, test, and measurement. 6
b) Differentiate between evaluation and measurement. 7
c) Write down the appropriate assessment name (in terms of their functional role in classroom) for the following cases: 12
(i) At the end of a lesson, a teacher gives his students a test to assess how much they have learned. This test is 20% of their semester grade.
(ii) A teacher is introducing his students to *bar graphs*. He is not sure that all of the students understand the material. He makes students to work in groups to create a simple *bar graph*. He observes the students as they work and collects the graphs to check for accuracy.
(iii) A student is struggling in all subject areas. He is a bright student and therefore his teacher, believes it is a reading disability. The teacher gives him multiple reading evaluations to assess where the problem lies.
(iv) Each week students receive 5 worked out problems. At the end of the week they take a test on the problems and their scores are recorded.

2. a) *At the beginning of the year, a teacher gave her students a test that contained questions focused on various topics that she planned to cover during the year. She wanted to see what her students already knew. She also wanted to compare the computational skills of each of her students for grouping purposes. After three months, the teacher feels that she needs to start to focus on preparing her students for the upcoming final exam. She gives her students the same test that they had taken at the beginning of the year to see what they have learned in the past four months. She looks at each student's test score individually and compares the two scores to see how much each has learned and the areas that she needs to review. Thereafter, the teacher designed another test that is similar to the final exam. Two weeks before the final exam, she gave this test to the students. She calculated the scores in the same way that the final exams will be scored. During scoring she identified areas where students scored poorly and emphasized instruction in those particular areas-* Name and discuss the frames of reference that the teacher used in her classroom. 13
b) Let's consider that a student took a *Norm Reference Test (NRT)* and a *Criterion Reference Test (CRT)* in the last month. Describe how the student's performance would have been affected on each test (*NRT* and *CRT*) if 12
(i) He was not fluent in English.
(ii) This was the first time the student was asked to take this kind of test.
(iii) The student came from a culture that seldom used tests to make important decisions.
(iv) The student and his parents believed that future success of the student depended on his performance on this test.

3. a) Why is the linear learning curve (shown below) not suitable to explain the growth reference test? Discuss. 12



b) A student exhibited a 40 score-point improvement from his pre-test to his post-test. His friend, a second student, only displayed a 15 score-point improvement from pre-test to post-test. Based on these test scores a teacher concludes that first student has learned more than the second student. How problematic is this conclusion in terms of growth reference interpretation? Explain it with the help of a *s-shaped* learning curve shown in the right-side figure. 13



4. a) Define *variance*, *interquartile range* and *standard deviation*. 6
   b) Find P_{25} and P_{50} in the following distribution of scores: 115, 112, 110, 108, 106, 104, 100, 100, 98, 96, 96, 94, 93, 91, 90, 88. 7
   c) Draw the necessary diagram and indicate the type of distribution (in terms of skewness) to which each of these following sets of data refer: 12
      (i) Mean = 78.37, median = 78.37, mode = 78.37
      (ii) Mean = 374.3, median = 379.7, mode = 391.3
      (iii) Mean = 109.5, median = 107.4, mode = 107.4

5. The following are the means and standard deviations of some well-known standardized tests, referred to as Test A, Test B, and Test C. All three yield normal distributions.

Test	*Mean*	*Standard Deviation*
Test A	500	100
Test B	100	15
Test C	60	10

   (i) A score of 325 on Test A corresponds to what score on Test C? A score of 640 on Test A corresponds to what score on Test B? 13
   (ii) The teacher told a student that he had scored so high on Test A that only 2 people out of 100 would score higher. What was the student's score on Test A? 12

6. a) The mean for the following distribution is 80, and the standard deviation is 12. Assuming a normal distribution, compute the z -scores and determine the rank order for the following students: 12

Student	*Student 1*	*Student 2*	*Student 3*	*Student 4*
Score	68	104	86	62

   b) Below are the times in minutes, spent on assignment one evening by a group of students. 13

Time Spent (min)	$0 \le t < 10$	$10 \le t < 20$	$20 \le t < 30$	$30 \le t < 40$	$40 \le t < 50$
Frequency	3	7	10	15	4

   Calculate cumulative frequency and cumulative percentage frequency for this data. Find out the top 10% of the students who spend the maximum time in their assignment.

7. a) Given a normal distribution with a mean of 50 and standard deviation of 15 13
      (i) What percent of the cases will lie between the scores of 47 and 60?
      (ii) What percent of the group is expected to have scores greater than 68?
   b) Four tests are passed by 15%, 50%, 60% and 75% respectively of a large unrelated group. Assuming normality, find the relative difficulty value of each problem. 12

8. a) There is a group of 1000 individuals to be divided into 10 subgroups, i.e. A, B, C, D, E, F, G, H, I and J respectively according to a trait supposed to be distributed normally. What number of individuals should be placed in each of these sub-groups? 15
   b) Given N = 100, M = 28.52, SD = 4.66; assuming normality of the given distribution, find what limits include the middle 60%? 10

Programme: BScTE (1-Year 2nd Sem, 2-Year 4th Semester) **Date**: Tuesday, 29 October 2019

Cumulative Standardized Normal Distribution

Area between the Mean and Successive Standard Deviation Units under the Normal Curve

$z(\frac{x}{\sigma})$	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0754
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2258	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2518	0.2549
0.7	0.2580	0.2612	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2996	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4383	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	.4987									

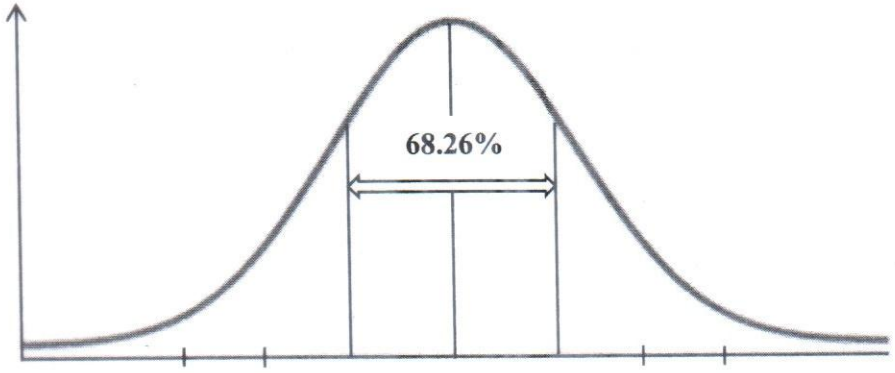


Figure: Area under Normal Curve

Programme: BScTE (1-Year 2nd Sem, 2-Year 4th Semester) **Date**: Tuesday, 29 October 2019

Formulae: TVE 4237

[The Parameters in the formulae have their usual meanings]

Measures of Central Tendency

$M = \frac{\Sigma fX}{N}$; $M = A + \frac{\Sigma fx}{N} \times i$;

$M_d = \left(\frac{N+1}{2}\right) th$; $M_d = L + \left[\frac{(N/2)-F}{f}\right] \times i$; or, $M_d = L + \frac{(P_{50}-F)}{f} * i$

$Mo = 3M_d - 2M$;

Measures of Variability

$SD = \sqrt{\frac{\Sigma x^2}{N}}$; $SD = \sqrt{\frac{\Sigma fx^2}{N}}$

IQR, $Q = q_3 - q_1$; Semi-interquartile range $= \frac{q_3 - q_1}{2}$

$\sigma_X^2 = \frac{\Sigma(X-\mu_X)^2}{N} = \frac{\Sigma\chi^2}{N}$ (σ is the Greek letter sigma.)

Percentiles

$PR = 100 - \frac{100R-50}{N}$; $PR = \frac{100}{N}\left[F + \left(\frac{X-L}{i}\right) \times f\right]$

Standardization of the scores (using normal curve)

$z = \frac{X-M}{\sigma}$

BSc (M) 2nd Sem October 30, 2019

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Final Semester Examination — Summer Semester, A. Y. 2018-2019
Course No.: MCE 4241 — Time: 3 Hours
Course Title: Computer Programming Applications — Full Marks: 100

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) Demonstrate the reasons for implementation of Arrays in C. Provide Examples. (4)

   b) Write a program to find out the average marks obtained by a class of 30 students in a test using Arrays. (10.67)

   c) How the actual parameters are passed to the formal parameters? Provide an example. (2)

2. a) Demonstrate the syntax of Function with example. (4)

   b) Write down the program which should demonstrate the multiplication of two Matrices using Arrays. (12.67)
   Note: Use 3*3 Matrix.

3. a) Write the output of a following program, (4)

```
Int main()

{
Int x = 20, *y, *z;

// Assume address of x is 500 and
// integer is 4 byte size
y = &x;
z = y;
*y++;
*z++;
x++;
printf("x = %d, y = %d, z = %d \n", x, y, z);
return 0;
}
```

   b) A positive integer is entered through the keyboard, write a program to obtain the prime factors of the number. Use Function without arguments and without return values. (12.67)

4. a) Using conditional operators determine: (5)
   I. Whether the character entered through the keyboard is lower case alphabet or not.
   II. Whether the character entered through the keyboard is special symbol or not.

b) Write a 'C' program which should demonstrate the following points by incorporating corresponding string functions, (5)

I. Concatenates two strings
II. Compare two strings
III. Calculate the length of a string
IV. Copies a string to another

c) Demonstrate the syntax and flow chart of For loop. (6.67)

5. a) Write a C-program to print out the first 10 numbers of Fibonacci sequence by using function. (12)

b) Elucidate the declaration and initialization of Structure. Provide an example. (4.67)

6. a) Write a 'C' program to accept customer details such as: Account_no, Name, Balance using structure. Assume 3 customers in the bank. Write a function to print the account no. and name of each customer whose balance < 1000 tk. (12)

b) Write a program to find out the slope of straight line using For loop. (4.67)

7. a) Write a C program which should reverse the number using recursion. (4)

b) Write a C-program to find out the Transpose of a Matrix using Arrays. (4.67)

c) Write a program to add numbers until the user enters zero. (5)

d) Write a small program which depicts the importance of value operator and address operator in pointers. (3)

8. a) Given a long character string and a short character string, find the number of occurrences of the short string in the long string, and print the beginning locations of each occurrence. (6.67)

b) Write a program to get the factorial value of a number given by a user using function. (6)

c) Write a 'C' program which should reveal the applicability of pointers in function. (4)

B.Sc. Engg. (M)/HDME, 4th Sem. October 31, 2019

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Final Semester Examination — Summer Semester, A. Y. 2018-2019
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.

---

1. a) In order to get a measured value from a true value, what are the elements involved in a measurement system? Describe them briefly. 13
   b) What kind of primary error can be seen in an instrument due to environmental inputs? How can you reduce this kind of error? 12

2. a) What do you mean by accuracy and precision? If you are asked to choose an instrument having a minimum economic budget, then which one are you going to choose within the below three options? Justify your answer? 13
   Options:
   i) Low Precision, Low accuracy
   ii) High Precision, Low accuracy
   iii) High Precision, High accuracy
   b) Draw sketches to illustrate the dynamic characteristics of the following: 12
   i) zero-order instrument
   ii) first-order instrument
   iii)second-order instrument
   In the case of a second-order instrument, indicate the effect of different degrees of damping on the time response.

3. a) What is hall effect? What are the different hall effect sensors? Explain them briefly. How a hall sensor can be used to measure a wheel rotational speed? 13
   b) What type of sensor can be used to measure the torque applied by a motor, turbine or engine to fans, generators, wheels or propellers? Explain with measuring arrangement. 12

4. a) What is an infrared thermometer? Explain the working principle of Infrared thermometer with schematic diagram. 13
   b) The thermocouple circuit shown in Figure 1 is used to measure the temperature T_1. The thermocouple reference junction labeled 2 is at a temperature of 34.6°C, and produces an output voltage of 18.2 mV. What temperature is exactly sensed by the measuring junction? (Thermocouple reference tables are attached with the question) 12

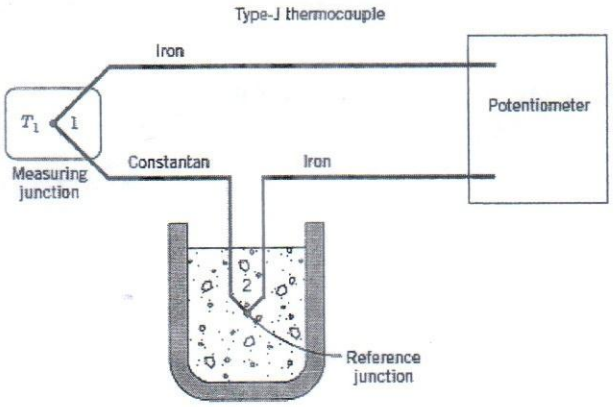

Figure 1 for Q 4 (b)

5. a) Is it possible to measure pressure by using a LVDT? If possible, then draw and explain it measuring arrangement. 13
   b) What is the working range of McLeod gauge? Briefly explain its working principle. 12

6. a) What is the main advantage of instrument amplifier over difference amplifier? Draw the circuit diagram of an instrument amplifier and derive the general expression of its output voltage. 13
   b) For 4.3 V, calculate is the digital output by using a Successive-Approximation ADC method? Also calculate the error. (10-bit A/D with range 0V – 10V) 12

7. a) What are the main two primary challenges of A/D conversion? Explain the following terms: 13
      i. Resolution
      ii. Device range
      iii. Signal input range
      iv. Sampling rate
   b) Explain the problem of using standard binary coding in optical encoders. How can you solve this problem? Explain. 12

8. a) Write down the working principle of positive displacement flowmeter. What is the major constrain of this flow meter and why? 13
   b) What is an ultrasonic sensor? How you can measure fluid level by ultrasonic sensor? Write down its advantages and disadvantages. 12

Table 8.5 Standard Thermocouple Compositions[a]

	Wire		
Type	Positive	Negative	Expected Systematic Uncertainty[b]
S	Platinum	Platinum/10% rhodium	±1.5°C or 0.25%
R	Platinum	Platinum/13% rhodium	±1.5°C
B	Platinum/30% rhodium	Platinum/6% rhodium	±0.5%
T	Copper	Constantan	±1.0°C or 0.75%
J	Iron	Constantan	±2.2°C or 0.75%
K	Chromel	Alumel	±2.2°C or 0.75%
E	Chromel	Constantan	±1.7°C or 0.5%

Alloy Designations

Constantan: 55% copper with 45% nickel

Chromel: 90% nickel with 10% chromium

Alumel: 94% nickel with 3% manganese, 2% aluminum, and 1% silicon

[a]From Temperature Measurements ANSI PTC 19.3-1974.

[b]Use greater value; these limits of error do not include installation errors.

Table 8.6 Thermocouple Reference Table for Type-J Thermocouple[a]

Temperature (°C)								Thermocouple emf (mV)		
	0	−1	−2	−3	−4	−5	−6	−7	−8	−9
−210	−8.095									
−200	−7.890	−7.912	−7.934	−7.955	−7.976	−7.996	−8.017	−8.037	−8.057	−8.076
−190	−7.659	−7.683	−7.707	−7.731	−7.755	−7.778	−7.801	−7.824	−7.846	−7.868
−180	−7.403	−7.429	−7.456	−7.482	−7.508	−7.534	−7.559	−7.585	−7.610	−7.634
−170	−7.123	−7.152	−7.181	−7.209	−7.237	−7.265	−7.293	−7.321	−7.348	−7.376
−160	−6.821	−6.853	−6.883	−6.914	−6.944	−6.975	−7.005	−7.035	−7.064	−7.094
−150	−6.500	−6.533	−6.566	−6.598	−6.631	−6.663	−6.695	−6.727	−6.759	−6.790
−140	−6.159	−6.194	−6.229	−6.263	−6.298	−6.332	−6.366	−6.400	−6.433	−6.467
−130	−5.801	−5.838	−5.874	−5.910	−5.946	−5.982	−6.018	−6.054	−6.089	−6.124
−120	−5.426	−5.465	−5.503	−5.541	−5.578	−5.616	−5.653	−5.690	−5.727	−5.764
−110	−5.037	−5.076	−5.116	−5.155	−5.194	−5.233	−5.272	−5.311	−5.350	−5.388
−100	−4.633	−4.674	−4.714	−4.755	−4.796	−4.836	−4.877	−4.917	−4.957	−4.997
−90	−4.215	−4.257	−4.300	−4.342	−4.384	−4.425	−4.467	−4.509	−4.550	−4.591
−80	−3.786	−3.829	−3.872	−3.916	−3.959	−4.002	−4.045	−4.088	−4.130	−4.173
−70	−3.344	−3.389	−3.434	−3.478	−3.522	−3.566	−3.610	−3.654	−3.698	−3.742
−60	−2.893	−2.938	−2.984	−3.029	−3.075	−3.120	−3.165	−3.210	−3.255	−3.300
−50	−2.431	−2.478	−2.524	−2.571	−2.617	−2.663	−2.709	−2.755	−2.801	−2.847
−40	−1.961	−2.008	−2.055	−2.103	−2.150	−2.197	−2.244	−2.291	−2.338	−2.385
−30	−1.482	−1.530	−1.578	−1.626	−1.674	−1.722	−1.770	−1.818	−1.865	−1.913
−20	−0.995	−1.044	−1.093	−1.142	−1.190	−1.239	−1.288	−1.336	−1.385	−1.433
−10	−0.501	−0.550	−0.600	−0.650	−0.699	−0.749	−0.798	−0.847	−0.896	−0.946
0	0.000	−0.050	−0.101	−0.151	−0.201	−0.251	−0.301	−0.351	−0.401	−0.451

Table 8.6 (*Continued*)

Temperature (°C)	Thermocouple emf (mV)									
	0	+1	+2	+3	+4	+5	+6	+7	+8	+9
0	0.000	0.050	0.101	0.151	0.202	0.253	0.303	0.354	0.405	0.451
10	0.507	0.558	0.609	0.660	0.711	0.762	0.814	0.865	0.916	0.968
20	1.019	1.071	1.122	1.174	1.226	1.277	1.329	1.381	1.433	1.485
30	1.537	1.589	1.641	1.693	1.745	1.797	1.849	1.902	1.954	2.006
40	2.059	2.111	2.164	2.216	2.269	2.322	2.374	2.427	2.480	2.532
50	2.585	2.638	2.691	2.744	2.797	2.850	2.903	2.956	3.009	3.062
60	3.116	3.169	3.222	3.275	3.329	3.382	3.436	3.489	3.543	3.596
70	3.650	3.703	3.757	3.810	3.864	3.918	3.971	4.025	4.079	4.133
80	4.187	4.240	4.294	4.348	4.402	4.456	4.510	4.564	4.618	4.672
90	4.726	4.781	4.835	4.889	4.943	4.997	5.052	5.106	5.160	5.215
100	5.269	5.323	5.378	5.432	5.487	5.541	5.595	5.650	5.705	5.759
110	5.814	5.868	5.923	5.977	6.032	6.087	6.141	6.196	6.251	6.306
120	6.360	6.415	6.470	6.525	6.579	6.634	6.689	6.744	6.799	6.854
130	6.909	6.964	7.019	7.074	7.129	7.184	7.239	7.294	7.349	7.404
140	7.459	7.514	7.569	7.624	7.679	7.734	7.789	7.844	7.900	7.955
150	8.010	8.065	8.120	8.175	8.231	8.286	8.341	8.396	8.452	8.507
160	8.562	8.618	8.673	8.728	8.783	8.839	8.894	8.949	9.005	9.060
170	9.115	9.171	9.226	9.282	9.337	9.392	9.448	9.503	9.559	9.614
180	9.669	9.725	9.780	9.836	9.891	9.947	10.002	10.057	10.113	10.168
190	10.224	10.279	10.335	10.390	10.446	10.501	10.557	10.612	10.668	10.723
200	10.779	10.834	10.890	10.945	11.001	11.056	11.112	11.167	11.223	11.278
210	11.334	11.389	11.445	11.501	11.556	11.612	11.667	11.723	11.778	11.8.34
220	11.889	11.945	12.000	12.056	12.111	12.167	12.222	12.278	12.334	12.389
230	12.445	12.500	12.556	12.611	12.667	12.722	12.778	12.833	12.889	12.944
240	13.000	13.056	13.111	13.167	13.222	13.278	13.333	13.389	13.444	13.500
250	13.555	13.611	13.666	13.722	13.777	13.833	13.888	13.944	13.999	14.055
260	14.110	14.166	14.221	14.277	14.332	14.388	14.443	14.499	14.554	14.609
270	14.665	14.720	14.776	14.831	14.887	14.942	14.998	15.053	15.109	15.164
280	15.219	15.275	15.330	15.386	15.441	15.496	15.552	15.607	15.663	15.718
290	15.773	15.829	15.884	15.940	15.995	16.050	16.106	16.161	16.216	16.272
300	16.327	16.383	16.438	16.493	16.549	16.604	16.659	16.715	16.770	16.825
310	16.881	16.936	16.991	17.046	17.102	17.157	17.212	17.268	17.323	17.378
320	17.434	17.489	17.544	17.599	17.655	17.710	17.765	17.820	17.876	17.931
330	17.986	18.041	18.097	18.152	18.207	18.262	18.318	18.373	18.428	18.483
340	18.538	18.594	18.649	18.704	18.759	18.814	18.870	18.925	18.980	19.035
350	19.090	19.146	19.201	19.256	19.311	19.366	19.422	19.477	19.532	19.587
360	19.642	19.697	19.753	19.808	19.863	19.918	19.973	20.028	20.083	20.139
370	20.194	20.249	20.304	20.359	20.414	20.469	20.525	20.580	20.635	20.690
380	20.745	20.800	20.855	20.911	20.966	21.021	21.076	21.131	21.186	21.241
390	21.297	21.352	21.407	21.462	21.517	21.572	21.627	21.683	21.738	21.793

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

Semester Final Examination
Course Code:Math 4411/Math 4699
Course Title: Linear Algebra

Summer Semester, A.Y. 2018-2019
Time: 3 hours
Full Marks: 150

There are **8 (Eight)** Questions. Answer any **6 (Six)** of them. Marks in the right margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper. The symbols have their usual meanings.

---

1. a) Solve the following system by Gaussian elimination method 12

$$2I_1 - I_2 + 3I_3 + 4I_4 = 9$$
$$I_1 - 2I_3 + 7I_4 = 11$$
$$3I_1 - 3I_2 + I_3 + 5I_4 = 8$$
$$2I_1 + I_2 + 4I_3 + 4I_4 = 10$$

b) The Figure Q 1b) shows a network of one-way streets with traffic flowing in the directions indicated. The flow rates along the streets are measured as the average number of vehicles per hour. 13

i. Set up a linear system equation whose solution provides the unknown flow rates.
ii. Solve the system for the unknown flow rates.
iii. If the flow along the road from A to B must be reduced for certain construction work, what is the minimum flow rate required to keep the traffic flowing on all roads?

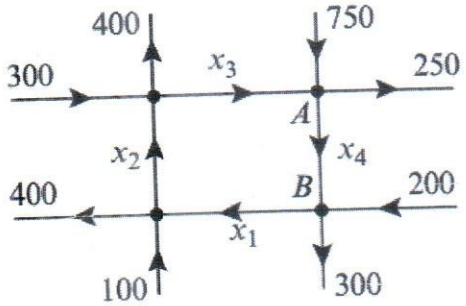

Figure Q 1b)

2. a) Use the inversion algorithm to find the inverse of the following matrix (if the inverse exists). 12

$$A = \begin{bmatrix} 2 & -4 & 0 & 0 \\ 1 & 2 & 12 & 0 \\ 0 & 0 & 2 & 0 \\ 0 & -1 & -4 & -5 \end{bmatrix}$$

b) Consider an economy with three sectors, Chemicals, Fuels, and Machinery. Chemicals sells 30% of its output to Fuels and 50% to Machinery and retains the rest. Fuels sells 80% of its output to Chemicals and 10% to Machinery and retains the rest. Machinery sells 40% to Chemicals and 40% to Fuels and retains the rest. 13

i. Construct the exchange table for this economy.
ii. Develop a system of equations that leads to prices at which each sector's income matches its expenses. Then write the augmented matrix that can be row-reduced to find these prices.
iii. Find a set of equilibrium prices other sectors when the price for the Machinery output is 100 units.

3. a) What is a block upper triangular matrix? Show that Matrix A is an invertible block upper triangular matrix and then find the inverse of the block upper triangular matrix A. 12

$$\text{Where } A=\begin{bmatrix} 4 & 7 & -5 & 3 \\ 3 & 5 & 3 & -2 \\ 0 & 0 & 7 & 2 \\ 0 & 0 & 3 & 1 \end{bmatrix}$$

b) Find an LU-decomposition of the coefficient matrix A, and use it to solve the system $Ax = b$ by forward substitution followed by back substitution approach. 13

$$\begin{bmatrix} 3 & -7 & -2 & 2 \\ -3 & 5 & 1 & 0 \\ 6 & -4 & 0 & -5 \\ -9 & 5 & -5 & 12 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix}=\begin{bmatrix} -9 \\ 5 \\ 7 \\ 11 \end{bmatrix}$$

4. a) Assume that the matrix A is row equivalent to B. Without calculations, list rank A and dim *Nul A*. Then find bases for *Col A*, *Row A*, and *Nul A*. 12

$$A=\begin{bmatrix} 1 & -4 & 9 & -7 \\ -1 & 2 & -4 & 1 \\ 5 & -6 & 10 & 7 \end{bmatrix},\quad B=\begin{bmatrix} 1 & 0 & -1 & 5 \\ 0 & -2 & 5 & -6 \\ 0 & 0 & 0 & 0 \end{bmatrix}$$

b) State Cayley-Hamilton theorem. Find the inverse matrix of A using the Cayley–Hamilton theorem 13

$$\text{Where } A=\begin{bmatrix} 1 & 1 & 2 \\ 9 & 2 & 0 \\ 5 & 0 & 3 \end{bmatrix}$$

5. a) Find the eigenvalues and eigenvectors of A, A^2, A^{-1} and $A + 4I$

$$\text{where } A=\begin{pmatrix} 2 & -1 \\ -1 & 2 \end{pmatrix}$$ 13

b) The circuit in Figure Q 5b) can be described by the following differential equation: 12

$$x_1'(t)=-\left[\left(1/R_1+1/R_2\right)x_1(t)\right]/C_1+x_2(t)/\left(R_2C_1\right)$$

$$x_2'(t)=x_1(t)/\left(R_2C_2\right)-x_2(t)/\left(R_2C_2\right)$$

where $x_1(t)$ and $x_2(t)$ are the voltages across the two capacitors at time t. Suppose resistor R_1 is 1 Ohm, R_2 is 2 Ohms, capacitor C_1 is 1 Farad, and C_2 is 0.5 Farad, and suppose there is an initial charge of 5 Volts on capacitor C_1 and 4 Volts on capacitor C_2.
Find formulas for $x_1(t)$ and $x_2(t)$ that describe how the voltages change over time.

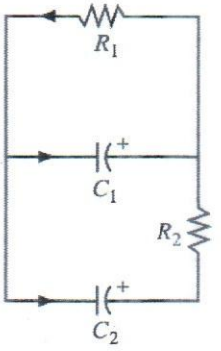

Figure Q 5b)

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DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination	Summer Semester	: **A.Y. 2018-2019**
Course Code: **MCE 4413**	Time	: **3.0 Hours**
Course Title: **Heat Transfer: Conduction & Radiation**	Full Marks	: **150**

There are **8 (Eight)** Questions. You **MUST** answer Questions No. **1 & 2.** Answer any **4 (Four)** from Questions **3** to **8**.
Do not write on the Question Paper. Marks in the Margin indicate the full marks. Assume any data if necessary.

---

1. Consider steady heat transfer in an L-shaped solid body whose cross section is given in **Fig. 1**. Heat transfer in the direction normal to the plane of the paper is negligible, and thus heat transfer in the body is two-dimensional. The thermal conductivity of the body is k, and heat is generated in the body at a rate of g. The left surface of the body is insulated, and the bottom surface is maintained at a uniform temperature of T. The entire top surface is subjected to convection to ambient air at T_α with a convection coefficient of h, and the right surface is subjected to heat flux at a uniform rate of q_R. The nodal network of the problem consists of 15 equally spaced nodes with $\Delta x=\Delta y=l$. Obtain the finite difference equations at all the nodes. **[25]**

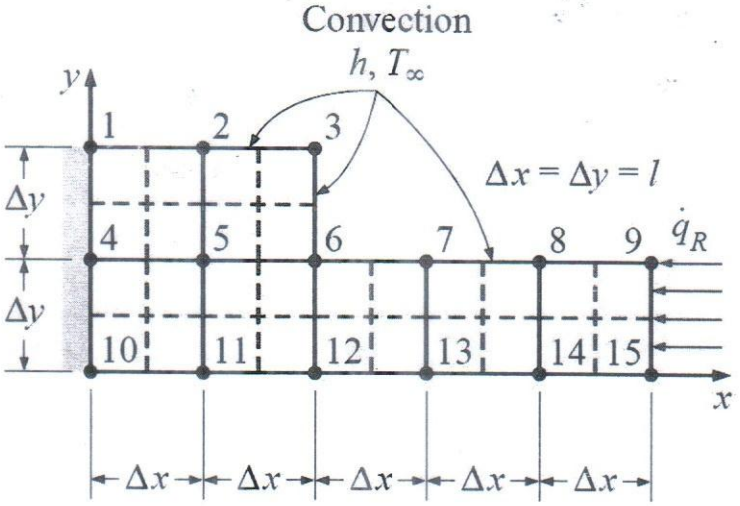


Figure: 1

2. Now, think the above setup for transient heat transfer with initial temperature at t=0 s, T_0=90°C. Other boundary conditions and properties are given below: **[25]**
$k=15\ W/m\cdot°C$, $\alpha=3.2x10^{-6}\ m^2/s$, $g=2x10^6\ W/m^3$, $T=90°C$, $T_\alpha=25°C$, $h=80\ W/m^2.°C$, $q_R=5000\ W/m^2$, $\Delta x=\Delta y=1.2\ cm$,
Using the implicit method, determine the temperature at *node 6* of the body after 10 minutes.

3. **[25]**
   a. Derive the expressions of Kirchhoff's Law for radiation heat transfer.
   b. Show and explain the Wien's displacement law for electromagnetic spectrum.
   c. Show that the solid angle for hemispherical water melon is 2Π Sr.

4. **[25]**
   a. Define view factor. Write down the fundamental relations for view factors.
   b. Calculate the space resistance for radiation heat transfer between any two surfaces.
   c. Show the influence of spectral transmissivity of low-iron glass on greenhouse effect.

5. A 3-m internal diameter spherical tank made of 2-cm-thick stainless steel (k=15 W/m·°C) is used to store iced water at $T_{\alpha 1}$=0°C as shown in **Fig. 2**. The tank is located in a room whose temperature is $T_{\alpha 2}$=22°C. The walls of the room are also at 22°C. The outer surface of the tank is black and heat transfer between the outer surface of the tank and the surroundings is by natural convection and radiation. The convection heat transfer coefficients at the inner and the outer surfaces of the tank are h_1=80 W/m^2.°C and h_2=10 W/m^2.°C, respectively. Determine (a) the rate of heat transfer to the iced water in the tank and (b) the amount of ice at 0°C that melts during a 24-h period. **[25]**

6. Find an expression for distribution of temperature and heat flow due to conduction in a circular conical rod with diameter as shown in **Fig. 3** at any section given by D=cx where x is the distance measured from the apex of the cone and c is a certain numerical constant. Assume that lateral surface is well insulated, there is no internal heat generation and heat flow takes place under steady state conditions. What will be the heat flow rate if the smaller and longer ends are located at x_1=50 mm and x_2=250 mm and have temperatures 400°C and 200°C respectively? Take: c=0.22 and k=3.6 W/m°C. **[25]**

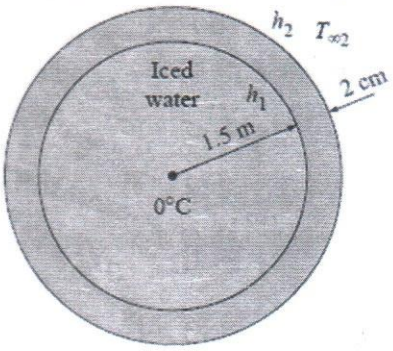


Figure: 2

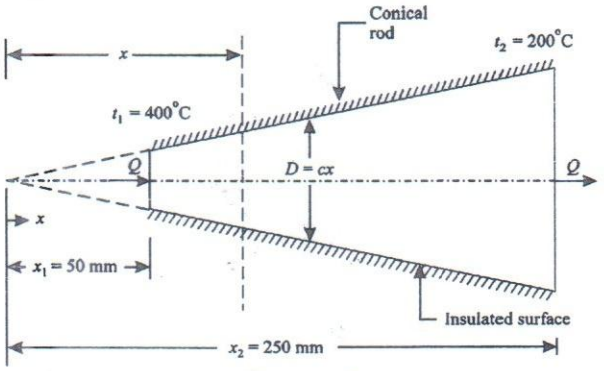


Figure: 3

7. A l high and m wide wall consists of long (w_B x h_B) cross section horizontal bricks (thermal conductivity, k_B) separated by 'h_P' thick plaster layers (k_p) as shown in **Fig. 4**. There are also w_P thick plaster layers on each side of the brick and w_F thick rigid foam (k_F) on the inner side of the wall. The indoor and the outdoor temperatures are $T_{\alpha 1}$ and $T_{\alpha 2}$, and the convection heat transfer coefficients on the inner and the outer sides are h_1 and h_2, respectively. Assuming one-dimensional heat transfer and disregarding radiation, determine the *rate of heat transfer* through the wall using thermal resistance network. **[25]**

8. Consider a cold aluminum canned drink that is initially at a uniform temperature of 3°C as shown in **Fig. 5**. 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 whose thermal conductivity is 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. **[25]**

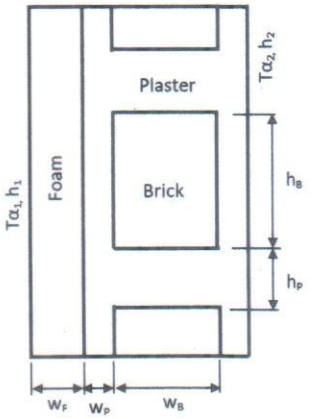


Figure: 4

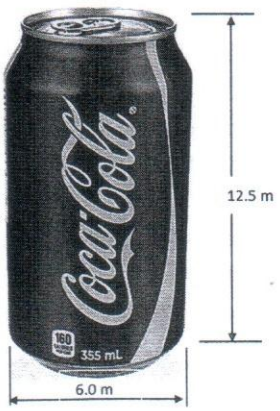
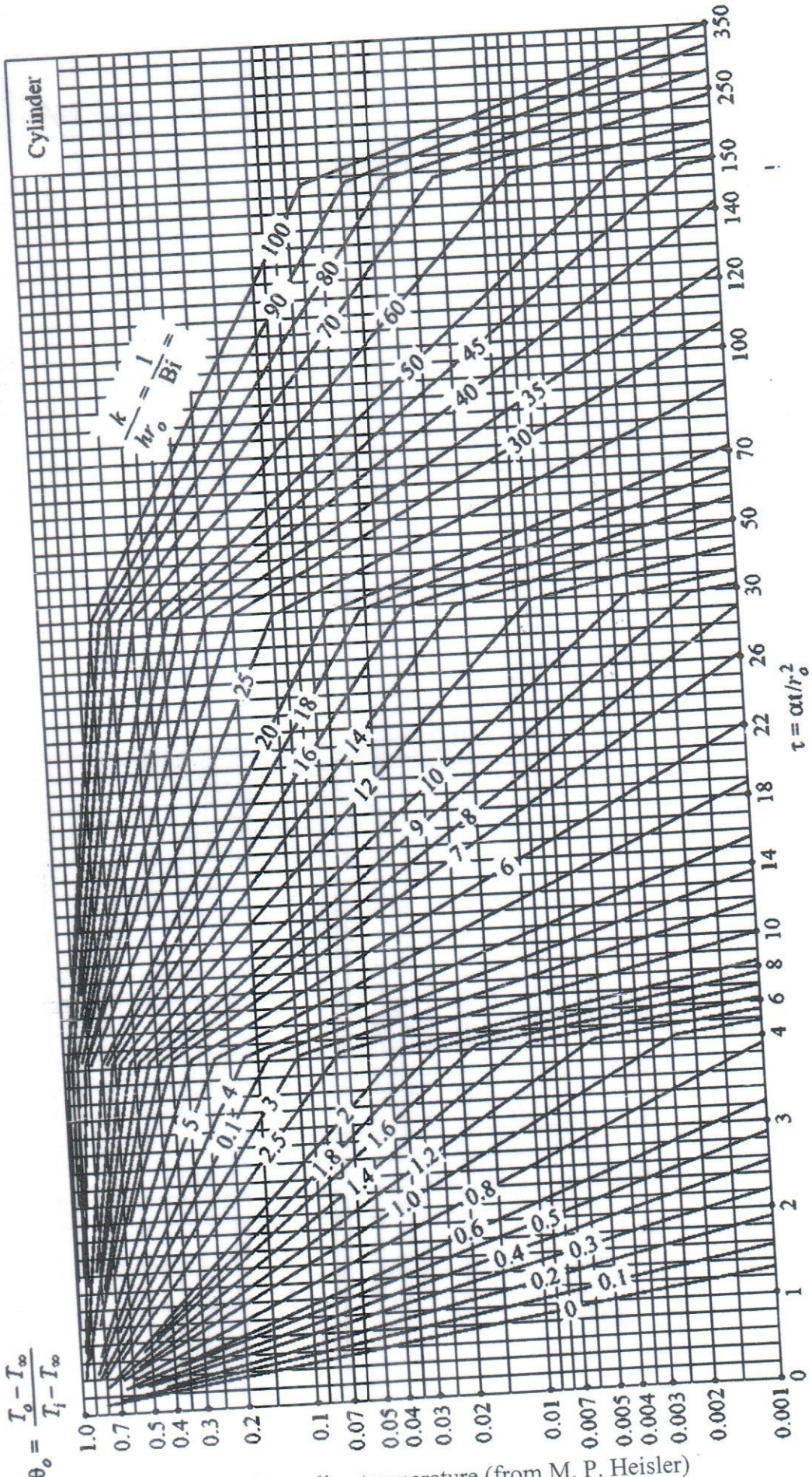
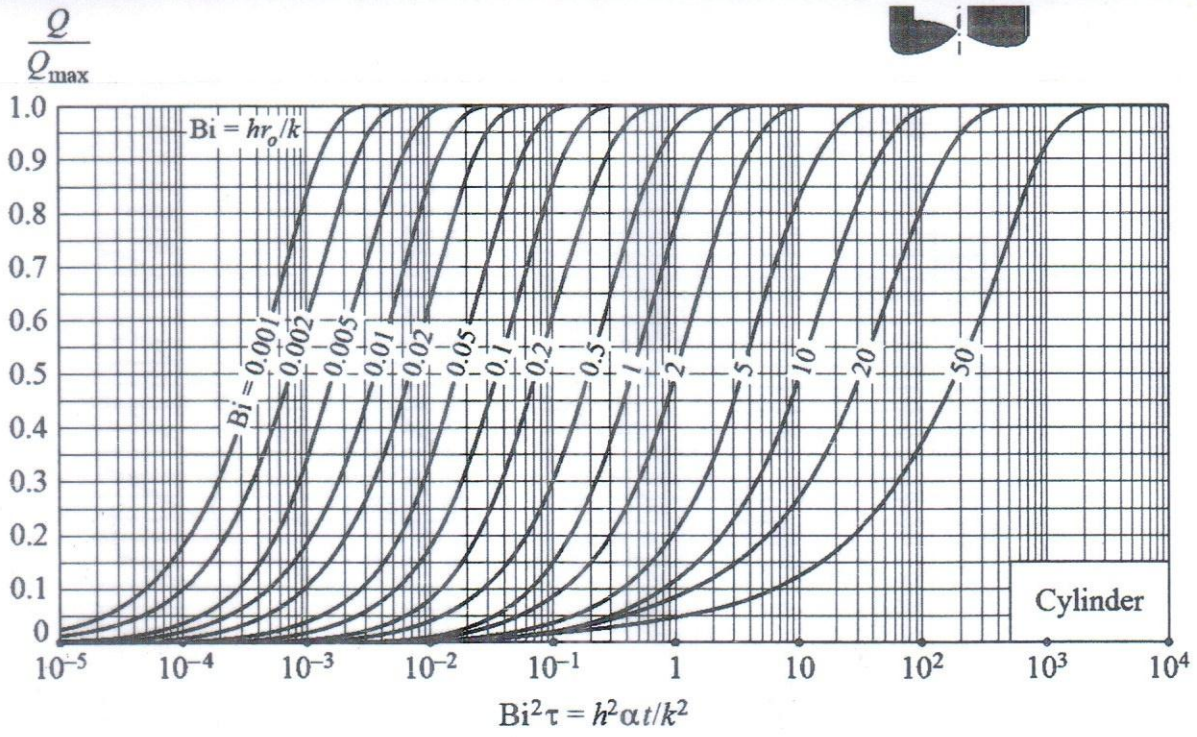


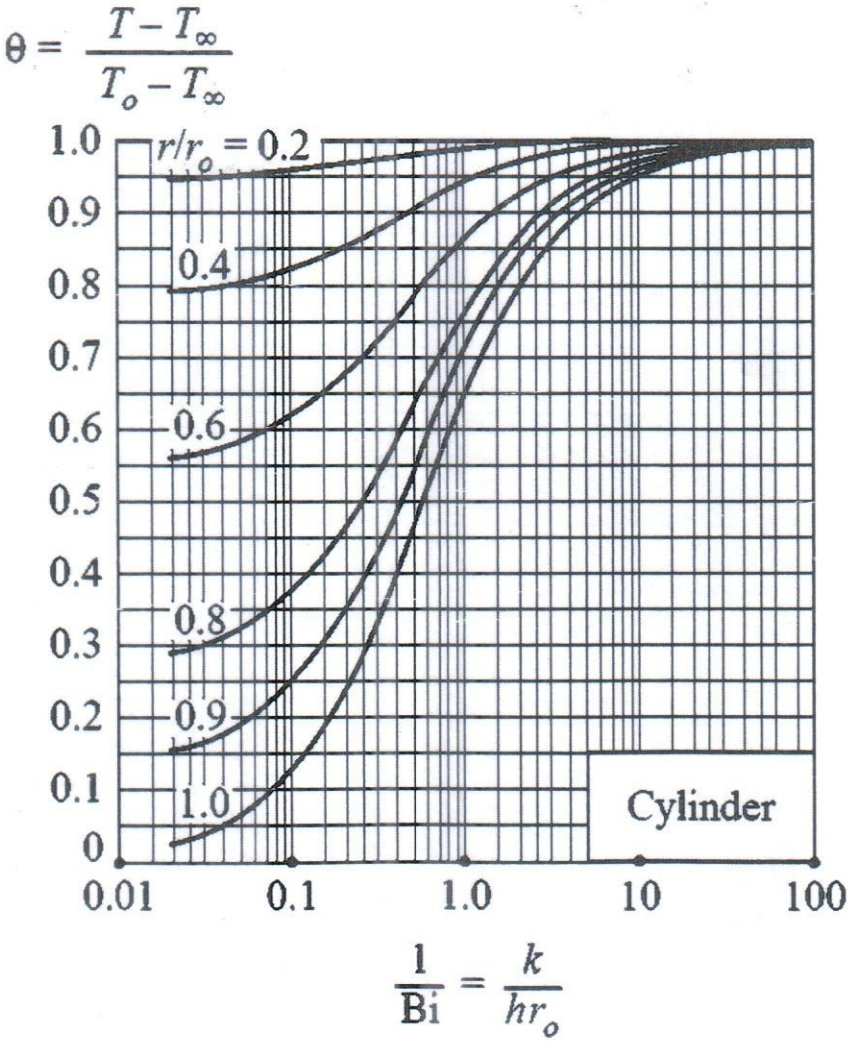
Figure: 5



(a) Centerline temperature (from M. P. Heisler)



(b) Heat transfer (from H. Gröber et al.)



(c) Temperature distribution (from M. P. Heisler)

PROGRAMME: B.Sc.Engg. (M) (4th Sem.) Date: 29 October 2019 (Tuesday)
HDME (4th Sem.)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANIZATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

SEMESTER FINAL EXAMINATION SUMMER SEMESTER: 2018-2019

COURSE NO. MCE 4425 TIME: 3 HOURS

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 sketch of the face centered cubic space lattice. Calculate the atomic packing factor for a face centered cubic crystal.
   (b) Sketch the following crystallographic planes and directions for the cubic system:
   (i) (110), (ii) (111), (iii) (333), (iv) [111], (v) [110], (vi) [101].
   (c) Distinguish between (i) hardness and toughness and (ii) ductility and malleability.
   (d) Draw a neat sketch of the iron blast furnace showing its salient parts.

2. (a) Draw a neat sketch of the basic open hearth furnace with regenerative system and describe briefly how steel is produced by the basic open hearth process of steel making. (12)
   (b) Why and how are deoxidation and recarburization carried out at the end of the steel making process? ($4^2/_3$)

3. (a) Define eutectic reaction and eutectoid reaction. (4)
   (b) Metal A and Metal B are completely soluble in both the liquid and solid states. The melting point of Metal A is 3225^0F and of Metal B is 1945^0F. An alloy containing 40 percent Metal B starts to solidify at 2910^0F by separating crystals of 15 percent Metal B. An alloy containing 70 percent Metal B starts to solidify at 2550^0F by separating crystals of 37 percent Metal B. ($12^2/_3$)

   (i) Draw the equilibrium diagram to scale on a piece of graph paper and label all points, lines and areas.

   (ii) For an alloy containing 70 percent Metal B
   (1) give the temperature of initial solidification;
   (2) give the temperature of final solidification;
   (3) give the chemical composition and relative amounts of the phases present at 2440^0F;
   (4) draw the cooling curve.

4. (a) Draw the iron and iron carbide thermal equilibrium diagram labeling all points, lines and phase fields. Define austenite and pearlite. ($12^2/_3$)
   (b) Mention the effect of carbon content on the yield strength, toughness, hardness and percentage (%) elongation of hot rolled plain carbon steel. (04)

5. (a) Draw a neat sketch of the Cupola furnace for the production of cast iron, showing its salient parts. ($6^2/_3$)
   (b) Classify cast iron. 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. (10)

6. (a) Define heat treatment? State 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)

7. (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) "Hardening a high carbon steel part by quenching is almost immediately followed by tempering." – Why? Mention the effect of tempering temperature on the hardness, toughness and residual stress of a quenched high carbon steel part. ($8^2/_3$)

8. (a) Mention advantages and limitation of alloy steel as compared to plain carbon steel. Suggest suitable material for the production of **any three** of the following machine components:
   (i) piston pin, (ii) crank shaft, (iii) truck gear, and (iv) leaf spring. (05)
   (b) What is stainless steel? Mention the main groups of stainless steel? Give their composition, properties and application. ($11^2/_3$)

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

Semester Final Examination — Summer Semester: A.Y. 2018-2019
Course Code: MCE 4461 — Time : 3 Hours
Course Title: Mechanical Technology II — Full Marks : 150

There are 8 (eight) questions. Answer any 6 (six) questions.
Assume any missing data. Do not write on the question paper.

1. a) Write down the working principle, characteristics and applications of LVDT. [10]

   b) What are the different types of instruments in measurement system? Explain briefly. [10]

   c) What are the three basic phenomena that can occur in a thermocouple circuit? [5]

2. a) Write down the general differential equation describing the dynamic response of a second order measuring instrument and state the expressions relating the static sensitivity, undamped natural frequency, and damping ratio to the parameters in this differential equation. Sketch the instrument response for cases of heavy damping, critical damping, and light damping and state which of these is the usual target when a second-order instrument is being designed? [10]

   b) What is bimetallic strip thermometer? How it can be used to measure temperature? [5]

   c) What are the ways to reduce the systematic errors in a measurement system? Explain briefly. [10]

3. a) What is hall effect sensor? Write down the working principle of hall effect sensor. [10]

   b) What is photo emissive transducer? How it works? What is photo tube? Describe all different types of photo tubes with diagram. [10]

   c) Explain types of analog and digital signals are used in any data acquisition system with proper diagram. [5]

4. a) Show a functional block diagram of a simple temperature control system. [5]

   b) A load cell is calibrated in an environment at a temperature of 21°C and has the following deflection/load characteristic: [10]

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 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 mm/°C and (mm per kg)/(°C).

   c) Write down the characteristic, advantage and different types of Piezoelectric Transducers. [10]

5. a) A pump supplies oil at 0.00127 m^3/s to a 50.8 mm diameter double acting hydraulic cylinder. If the load is 4450 N (extending and retracting) and the rod diameter is 25.4 mm. Find pressure, velocity and power for extending and retracting stroke. [10]

b) What is lobe pump? Explain with proper diagram. [5]

c) Explain gear motor's working principle with proper diagram. [10]

6. a) [10]

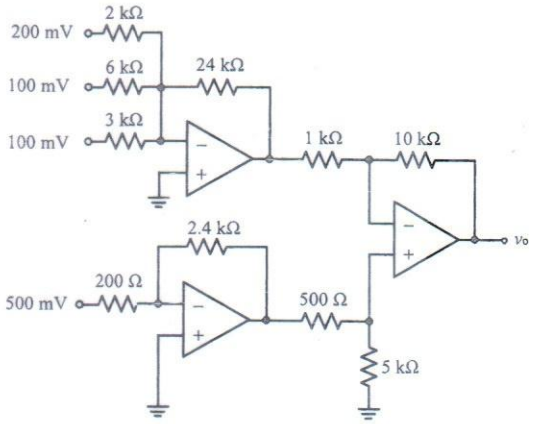


Figure 1

Calculate the voltage v_o in figure 1.

b) To measure the average temperature different between junctions which type of thermocouple arrangement is used? Explain with proper schematic diagram. Write down the basic method of measuring temperature using thermocouple. [10]

c) The output e.m.f. from a chromel-alumel thermocouple (K type) whose hot junction is immersed in a fluid is measured as 6.07 mV. The reference junction of the thermocouple is maintained at 0 °C. What is the temperature of the fluid? [5]

ITS-90 Table for Type K Thermocouple (Ref Junction 0°C)

°C	0	1	2	3	4	5	6	7	8	9	10
	Thermoelectric Voltage in mV										
0	0.000	0.039	0.079	0.119	0.158	0.198	0.238	0.277	0.317	0.357	0.397
10	0.397	0.437	0.477	0.517	0.557	0.597	0.637	0.677	0.718	0.758	0.798
20	0.798	0.838	0.879	0.919	0.960	1.000	1.041	1.081	1.122	1.163	1.203
30	1.203	1.244	1.285	1.326	1.366	1.407	1.448	1.489	1.530	1.571	1.612
40	1.612	1.653	1.694	1.735	1.776	1.817	1.858	1.899	1.941	1.982	2.023
50	2.023	2.064	2.106	2.147	2.188	2.230	2.271	2.312	2.354	2.395	2.436
60	2.436	2.478	2.519	2.561	2.602	2.644	2.685	2.727	2.768	2.810	2.851
70	2.851	2.893	2.934	2.976	3.017	3.059	3.100	3.142	3.184	3.225	3.267
80	3.267	3.308	3.350	3.391	3.433	3.474	3.516	3.557	3.599	3.640	3.682
90	3.682	3.723	3.765	3.806	3.848	3.889	3.931	3.972	4.013	4.055	4.096
100	4.096	4.138	4.179	4.220	4.262	4.303	4.344	4.385	4.427	4.468	4.509
110	4.509	4.550	4.591	4.633	4.674	4.715	4.756	4.797	4.838	4.879	4.920
120	4.920	4.961	5.002	5.043	5.084	5.124	5.165	5.206	5.247	5.288	5.328
130	5.328	5.369	5.410	5.450	5.491	5.532	5.572	5.613	5.653	5.694	5.735
140	5.735	5.775	5.815	5.856	5.896	5.937	5.977	6.017	6.058	6.098	6.138

7. **a)** A pressure relief valve (PRV) contains a poppet with a 4.2 cm^2 area on which system pressure acts. During assembly a spring with a spring constant of 3200N/cm^2 is installed in the valve to hold the poppet against its seat. The adjustment mechanism is then set so that the spring is initially compressed 0.50 cm from its free-length condition. In order to pass full pump flow through the valve at the PRV pressure setting, the poppet must move 0.30 cm from its fully closed position. Determine the [10]

   a. Cracking pressure
   b. Fully pump flow pressure (PRV pressure setting)

b) What is needle valve? How it works? [5]

c) Draw the schematic diagram of double-pump hydraulic system and explain its working principle. [10]

8. **a)** Write down the working principle of double acting cylinder. [5]

b) What is the working principle of check valve? Explain with appropriate figures. [10]

c) A double-acting cylinder is hooked up in the regenerative circuit of figure 2. The relief valve setting is 105 bars. The piston area is 130 cm^2 and the rod area is 65 cm^2. If the pump flow is 0.0016 m^3/s find the cylinder speed and load-carrying capacity and power delivered to the load (assuming the load equals to the cylinder load-carrying capacity) during the [10]

   a. Extending stroke.
   b. Retracting stroke.

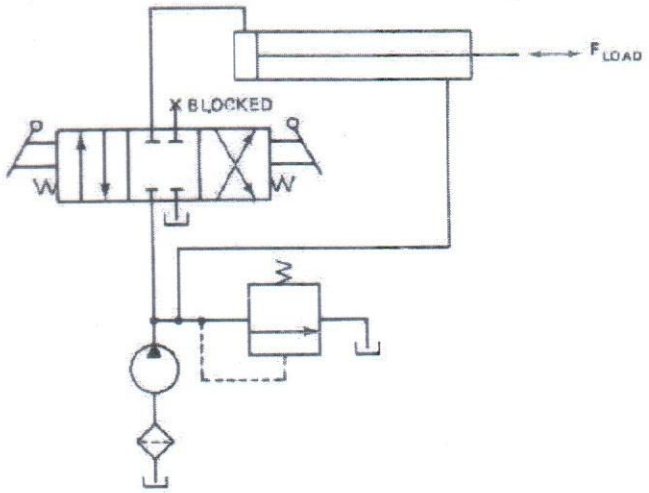


Figure 2

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

October 23, 2019

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

FINAL SEMESTER EXAMINATION — SUMMER SEMESTER: 2018-2019

COURSE NO: MCE 4403 /MCE 4695 — TIME : 3.00 HRS

COURSE TITLE: MECHANICS OF MATERIALS — **FULL MARKS : 200**

There are **EIGHT** Questions. Answer any **SIX** Questions.

Marks in the Margin indicate full marks. Assume data if missing or necessary.

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

1. (a) Derive the expression $\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$ for the pure torsion of a solid or hollow shaft of uniform cross-section throughout its length. (14)

   (b) A compound stepped shaft fabricated from steel and bronze is loaded by two twisting moments as shown in Fig.1. The diameters of the steel and bronze segments are respectively 60 mm and 55 mm. If the allowable shearing stress in steel is 80 MPa, allowable shearing stress in bronze is 40 MPa and angle of twist at the free end is limited to 5^0, determine the maximum value of torque T. Modulus of rigidity for steel and bronze are respectively 80 GPa and 35 GPa. (19.33)

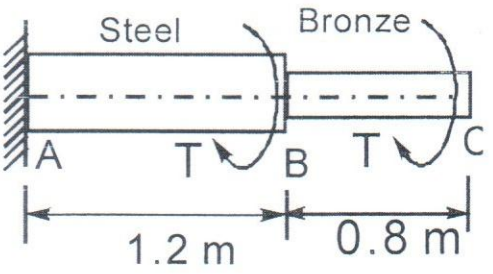


Fig.1

2. (a) Derive the relationship between E, G and ν such that $E = 2G(1 + \upsilon)$. Symbols represent the usual meanings. (13.33)

   (b) A material is subjected to two mutually perpendicular strains, $\varepsilon_x = 450 \times 10^{-6}$ and $\varepsilon_y = 90 \times 10^{-6}$, together with an unknown shear strain γ_{xy}. If the principal strain in the material is 550×10^{-6}, determine by the Mohr's strain circle: (20)

   i) The magnitude of the shear strain;
   ii) The other principal strain;
   iii) Draw the Mohr's stress circle from the Mohr's strain circle;
   iv) The magnitude of the principal stresses from the Mohr's stress circle; and
   v) The maximum shear stress from the Mohr's stress circle.

   Take E =200 GPa and ν=0.3.

3. A solid circular shaft of diameter 75 mm is subjected to an axial load P = 150 kN and a torque T=1000 Nm as shown in Fig.2. Determine the normal and shearing stresses on the spiral weld plane that makes an angle of 40^0 with the axis of the shaft. (33.33)

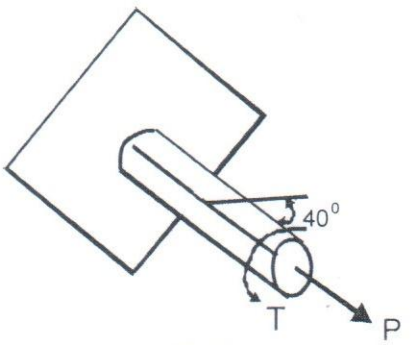


Fig.2

4. A circular shaft, 100 mm diameter is subjected to combined bending moment and torque, the bending moment being 2 times the torque. If the direct tension yield point of the material is 300 MPa and the factor of safety is to be 3, determine the allowable twisting moment by the three following theories of failure: (33.33)

   i) Maximum principal stress theory;
   ii) Maximum shear stress theory;
   iii) Maximum shear strain energy/ volume theory.

5. (a) Derive the expression of critical or crippling load for a column with both ends hinged. (13.33)

   (b) A T-section 150 mm×120 mm×20 mm is used as a strut of 4 m long with hinged at its both ends. Determine the crippling load if Young's modulus for the material be 200 GPa. Determine also the minimum value of the slenderness ratio at which Euler's formula is valid, and find the minimum effective length of the column. (20)

6. (a) Derive the Mohr's area moment formula for determination of slope and deflection of a beam at any point. (8.33)

   (b) An overhanging beam carries uniformly distributed loads of w from its free end to the nearest support at its both ends shown in Fig.3. Using area moment method, determine the expressions of deflection and the slope at its end. (25)

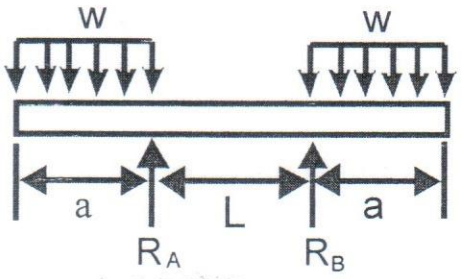


Fig. 3

7. (a) A close-coiled helical spring is to have a stiffness of 90 kN/m and to exert a force of 3 kN; the mean diameter of the coils is to be 75mm and the maximum stress is not to exceed 240 MPa. Determine the required number of coils and the diameter of the steel rod from which the spring should be made. Take E=210 GPa and G = 70 GPa. (13.33)

   (b) A leaf spring 750 mm long is required to carry a central point load of 8 kN. If the central deflection is not to exceed 20 mm and the bending stress is not to greater than 200 MPa, determine the thickness, width and number of plates. Also compute the radius of curvature. Assume width of the plate is equal to 12 times its thickness and E=200 GPa. (20)

8. In a certain material under load a plane AB carries a tensile direct stress of 30 MPa and a shear stress of 20 MPa, while another plane BC carries a tensile direct stress of 20 MPa and a shear stress. If the planes are inclined to one another at 30^0 and plane AC at right angles to plane AB carries a direct stress unknown in magnitude and nature as shown in Fig.4, determine: (33.33)

   i) The value of the shear stress on BC;
   ii) The magnitude and nature of the direct stress on AC;
   iii) The principal stresses.

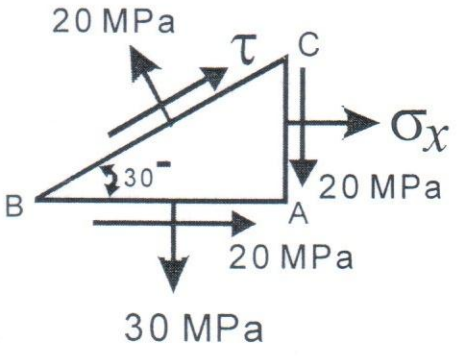


Fig.4

B.Sc. Engg (M) 6th Sem 23 October 2019

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

Semester Final Examination — Summer Semester: A.Y. 2019-2020
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) The concentration of salt x in a home-made soap maker is given as a function of time by **15**

$$\frac{dx}{dt} = 37.5 - 3.5x$$

At the initial time, t = 0, the salt concentration in the tank is 50 g/L. Using Runge-Kutta 4th order method and a step size of h=1.5 min, find the salt concentration after 3 minutes.

b) The temperature distribution in the wall of a pipe through which a hot liquid is flowing is given by the given differential equation **10**

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

T(1) = 100 °C and T(2) = 0 °C. Determine the temperature distribution in the wall with a step size of $\Delta r = 0.25$ using Runge-Kutta 2nd order method (Heun's method).

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 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= .005%.

3. a) The upward velocity v of a rocket is given as a function of time t. Determine the value of the velocity at t = 16 seconds using second order polynomial interpolation using Newton's divided difference polynomial method. **12**

t(s)	10	15	20	22.5
v(m/s)	227.04	362.78	517.35	602.97

b) The upward velocity v of a rocket is given as a function of time t. Determine the value of the velocity at t = 16 and 21.5 seconds using quadratic splines as velocity functions. **13**

t(s)	15	20	22.5
v(m/s)	362.78	517.35	602.97

4. 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 finite difference method to find the position at different times using $\Delta t = 3s$, for the boundary conditions: $x(0) = 0$, $x(12) = 500$.

b) The conservation of heat can be used to develop a heat balance for a long, thin rod. If the rod is not insulated along its length and the system is at a stead state, the equation that results is **12**

$$\frac{d^2T}{dx^2} + h'(T_a - T) = 0$$

Use the shooting method to solve the equation for a 10 m rod with $h' = 0.01m^{-2}$ and $T_a = 20$, and the boundary conditions T(0)=40, T(10)=200. While solving in shooting, use the Euler method internally with step size of 5m. (Hint: Use the guesses $\frac{dT}{dx}(0) = 10$ and $\frac{dT}{dx}(0) = 20$ and then interpolate to find the required $\frac{dT}{dx}$)

5. Find the temperature distribution of the plate given in the figure 01 using finite difference method. **25**
$\Delta x = \Delta y$

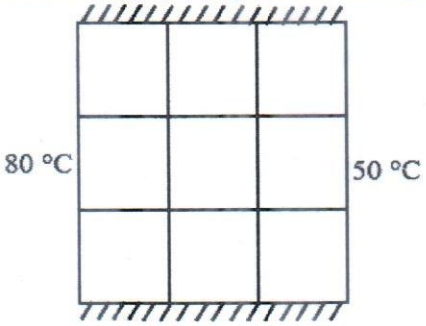


figure 01

6. Find the temperature distribution of the plate given in the figure 02 using finite difference method. **25**
$\Delta x = \Delta y$, $\alpha_1 = \beta_1 = 0.5$ and $\alpha_2 = \beta_2 = 1$.

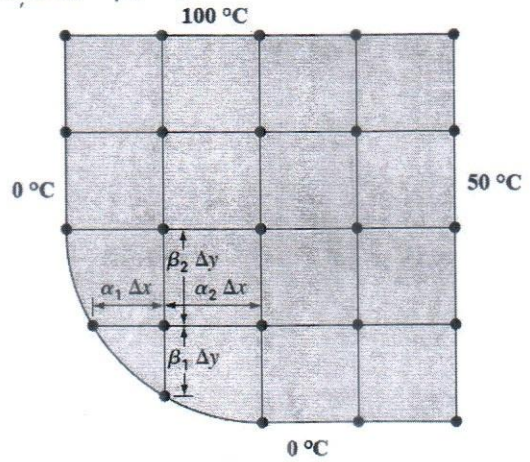


figure 02

7. a) What are the conditions that a numerical solution must satisfy to be convergent? Find the limit of step size required for the numerical solution of the given differential equation to be convergent. **7**

$$\frac{dy}{dt} = -5y$$

b) Use the explicit 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**

8. A rod of steel is subjected to a temperature of 100^0C on the left end and 25^0C on the right end. If the rod is of length 0.05m, use the implicit method to find the temperature distribution in the rod from t = 0 to t = 9 seconds. Use $\Delta x = 0.01$m and $\Delta t = 3$s with $\lambda = 0.4239$, where, λ bears the usual meaning. **25**

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

29 October, 2019

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. 2018-2019
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 are provided on a separate page with the question. Assume reasonable values for any missing data. Programmable calculators are not allowed.

1. a) Derive the expression for evaporation rate of a species A per unit interface area when diffusing through a stagnant gas. [08]
   b) Consider a carbonated drink in a bottle at 37°C and 130 kPa. Assuming the gas space above the liquid consists of a saturated mixture of CO_2 and water vapor and treating the drink as water, determine (a) the mole fraction of the water vapor in the CO_2 gas and (b) the mass of dissolved CO_2 in a 200-ml drink. The saturation pressure of water at 37°C is 6.33 kPa. [12]
   c) Discuss the various mechanisms of heat transfer involved during the evaporation of water from the surface of a lake. [05]

2. a) What is the most important difference between heat transfer and mass transfer in terms of the boundary conditions? Elaborate. [06]
   b) The solubility of hydrogen gas in steel in terms of its mass fraction is given as $w_{H_2} = 2.09 \times 10^{-4} \exp(-3950/T) P_{H_2}^{0.5}$ where P_{H_2} is the partial pressure of hydrogen in bars and T is the temperature in K. If natural gas is transported in a 1-cm-thick, 3-m-internal-diameter steel pipe at 500 kPa pressure and the mole fraction of hydrogen in the natural gas is 8 percent, determine the highest rate of hydrogen loss through a 100-m-long section of the pipe at steady conditions at a temperature of 293 K if the pipe is exposed to air. Take the diffusivity of hydrogen in steel to be 2.9×10^{-13} m^2/s. The density of steel pipe is 7854 kg/m^3. [08]
   c) A metallic airfoil of elliptical cross section has a mass of 50 kg, surface area of 12 m^2, and a specific heat of 0.50 kJ/kg·K. The airfoil is subjected to air flow at 1 atm, 25°C, and 5 m/s along its 3-m-long side. The average temperature of the airfoil is observed to drop from 160°C to 150°C within 2 min of cooling. Assuming the surface temperature of the airfoil to be equal to its average temperature, determine the average friction coefficient of the airfoil surface. Note the difference you would see if the velocity has been changed to 10 m/s. [06]
   d) Discuss the mass transfer due to natural convection. [05]

3. a) Develop an expression of the effectiveness of a parallel-flow heat exchanger. [17]
   b) A double-pipe parallel-flow heat exchanger is to heat water (c_p = 4180 J/kgK) from 25°C to 60°C at a rate of 0.2 kg/s. The heating is to be accomplished by geothermal water (c_p = 4310 J/kgK) available at 140°C at a mass flow rate of 0.3 kg/s. The inner tube is thin-walled and has a diameter of 0.8 cm. If the overall heat transfer coefficient of the heat exchanger is 550 W/m^2K, determine the length of the tube required to achieve the desired heating. [08]

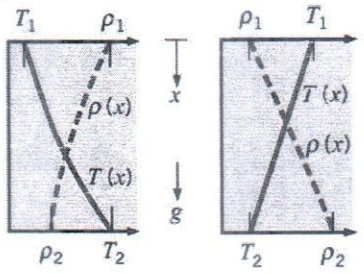
4. a) Elaborate on different points and regions of typical boiling curve for water at 1 atm with a neat figure. [10]

b) Hot oil (c_p = 2200 J/kgK) is to be cooled by water (c_p = 4180 J/kgK) in a 2-shell-passes and 12-tube-passes heat exchanger. The tubes are thin-walled and are made of copper with a diameter of 1.8 cm. The length of each tube pass in the heat exchanger is 3 m, and the overall heat transfer coefficient is 340 W/m^{2}K. Water flows through the tubes at a total rate of 0.1 kg/s, and the oil through the shell at a rate of 0.2 kg/s. The water and the oil enter at temperatures 18^{0}C and 160^{0}C, respectively. Determine the rate of heat transfer in the heat exchanger and the outlet temperatures of the water and the oil. [12]

c) With figures, distinguish between buoyant jet and plume. [03]

5. a) Steam in the condenser of a power plant is to be condensed at a temperature of 30^{0}C with cooling water from a nearby lake, which enters the tubes of the condenser at 14^{0}C and leaves at 22^{0}C. The surface area of the tubes is 45 m^2, and the overall heat transfer coefficient is 2100 W/m^{2}K. Determine the mass flow rate of the cooling water needed and the rate of condensation of the steam in the condenser. The heat of vaporization of water at 30^{0}C is h_{fg} = 2431 kJ/kg. c_p of water at 18^{0}C is 4184 J/kgK. [08]

b) [05]



i) ii)

Figures (i) and (ii) show the conditions in a fluid between large horizontal plates at different temperatures for two different cases. Discuss the heat transfer modes in these two cases.

c) A 10-m-long metal pipe (k_{pipe} = 15 W/m·K) has an inner diameter of 5 cm and an outer diameter of 6 cm is used for transporting hot saturated water vapor at a flow rate of 0.05 kg/s. The water vapor enters and exits the pipe at 350°C and 290°C, respectively. In order to prevent thermal burn on individuals working in the vicinity of the pipe, the pipe is covered with a 2.25-cm thick layer of insulation (k_{ins} = 0.95 W/m·K) to ensure that the outer surface temperature $T_{s,o}$ is below 45°C. Determine whether or not the thickness of the insulation is sufficient to alleviate the risk of thermal burn hazards. [12]

6. a) Show that, for fully developed laminar flow in a circular tube subjected to constant surface heat flux, the Nusselt number is a constant. [13]

b) A 6-m-long section of an 8-cm-diameter horizontal hot-water pipe passes through a large room whose temperature is 20^{0}C. If the outer surface temperature of the pipe is 70^{0}C, determine the rate of heat loss from the pipe by natural convection. [12]

7. a) Elaborate on cross-flow over a cylinder in terms of the fluid flow and heat transfer. Delineate the boundary layer formation and separation and the effect of turbulence with relevant figures [10]

b) During a cold winter day, wind at 55 km/h is blowing parallel to a 4-m-high and 10-m-long wall of a house. If the air outside is at 5^{0}C and the surface temperature of the wall is 12^{0}C, determine the rate of heat loss from that wall by convection. What would your answer be if the wind velocity was doubled? [10]

c) With neat figures, elaborate the development of velocity boundary layer over a flat plate. [05]

8. a) Discuss, in details, the analogy between momentum, heat and mass transfer. [10]

b) During a certain experiment involving the flow of dry air at 25°C and 1 atm at a free stream velocity of 2 m/s over a body covered with a layer of naphthalene, it is observed that 12 g of naphthalene has sublimated in 15 min. The surface area of the body is 0.3 m^2. Both the body and the air were kept at 25°C during the study. The vapor pressure of naphthalene at 25°C is 11 Pa and the mass diffusivity of naphthalene in air at 25°C is $D_{AB} = 0.61 \times 10^{-5}$ m^2/s. Determine the heat transfer coefficient under the same flow conditions over the same geometry. The molar mass of naphthalene is 128.2 kg/kmol. [10]

c) With the help of thermal resistance network, develop an expression for overall heat transfer coefficient. [05]

TABLE 14–6

Henry's constant H (in bars) for selected gases in water at low to moderate pressures (for gas i, $H = P_{i,\text{ gas side}}/y_{i,\text{ water side}}$)
(from Mills, 1995; Table A.21)

Solute	290 K	300 K	310 K	320 K	330 K	340 K
H_2S	440	560	700	830	980	1140
CO_2	1280	1710	2170	2720	3220	—
O_2	38,000	45,000	52,000	57,000	61,000	65,000
H_2	67,000	72,000	75,000	76,000	77,000	76,000
CO	51,000	60,000	67,000	74,000	80,000	84,000
Air	62,000	74,000	84,000	92,000	99,000	104,000
N_2	76,000	89,000	101,000	110,000	118,000	124,000

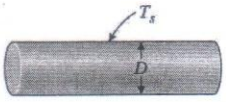
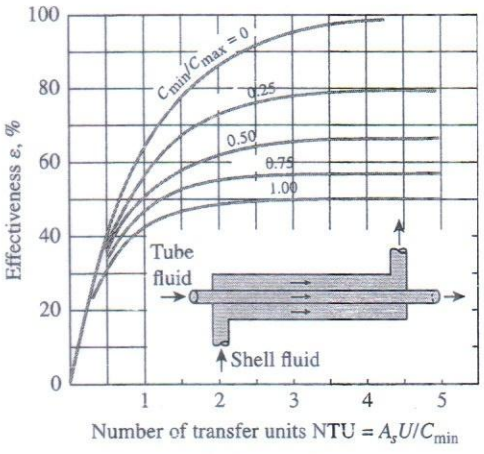
Horizontal cylinder 	D	$Ra_D \le 10^{12}$	$Nu = \left\{0.6 + \frac{0.387Ra_D^{1/6}}{[1 + (0.559/Pr)^{9/16}]^{8/27}}\right\}^2$	(9–25)

TABLE 8.4 Summary of convection correlations for flow in a circular tube[a,b,c]

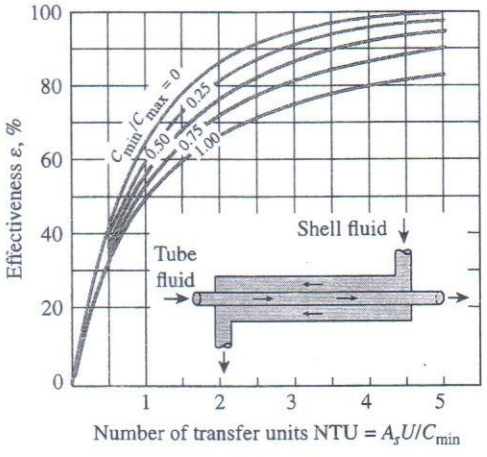
$Nu_D = 0.023\, Re_D^{4/5}\, Pr^n$	(8.60)[d]	Turbulent, fully developed, $0.6 \le Pr \le 160$, $Re_D \ge 10{,}000$, $(L/D) \ge 10$, $n = 0.4$ for $T_s > T_m$ and $n = 0.3$ for $T_s < T_m$
$Nu_D = 0.027\, Re_D^{4/5}\, Pr^{1/3}\left(\frac{\mu}{\mu_s}\right)^{0.14}$	(8.61)[d]	Turbulent, fully developed, $0.7 \le Pr \le 16{,}700$, $Re_D \ge 10{,}000$, $L/D \ge 10$
$Nu_D = \frac{(f/8)(Re_D - 1000)\,Pr}{1 + 12.7(f/8)^{1/2}(Pr^{2/3} - 1)}$	(8.62)[d]	Turbulent, fully developed, $0.5 \le Pr \le 2000$, $3000 \le Re_D \le 5 \times 10^6$, $(L/D) \ge 10$

TABLE 7.7 Summary of convection heat transfer correlations for external flow[a,b]

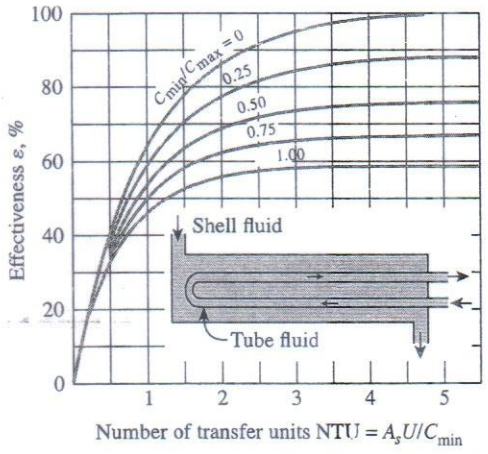
Correlation		Geometry	Conditions[c]
$Nu_x = 0.0296\, Re_x^{4/5}\, Pr^{1/3}$	(7.36)	Flat plate	Turbulent, local, T_f, $Re_x \le 10^8$, $0.6 \le Pr \le 60$
$\overline{C}_{fL} = 0.074\, Re_L^{-1/5} - 1742\, Re_L^{-1}$	(7.40)	Flat plate	Mixed, average, T_f, $Re_{x,c} = 5 \times 10^5$, $Re_L \le 10^8$
$\overline{Nu}_L = (0.037\, Re_L^{4/5} - 871)Pr^{1/3}$	(7.38)	Flat plate	Mixed, average, T_f, $Re_{x,c} = 5 \times 10^5$, $Re_L \le 10^8$, $0.6 \le Pr \le 60$



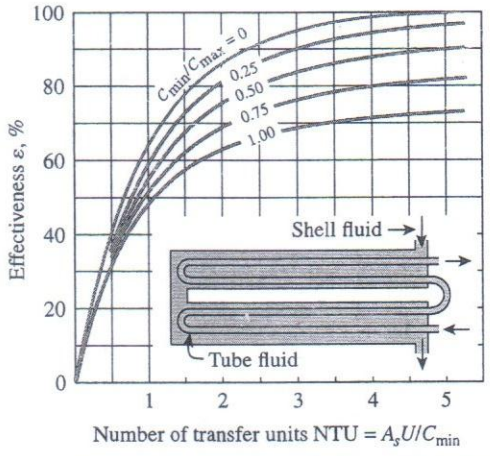
(*a*) Parallel-flow



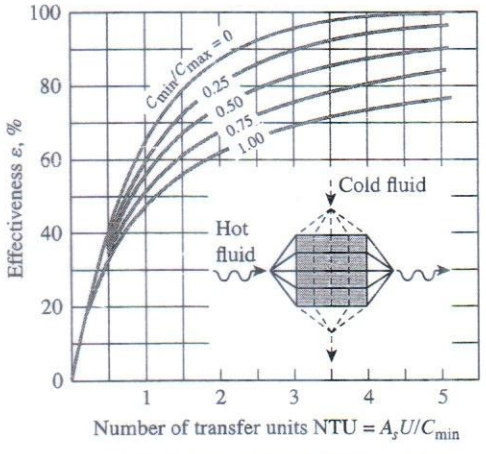
(*b*) Counter-flow



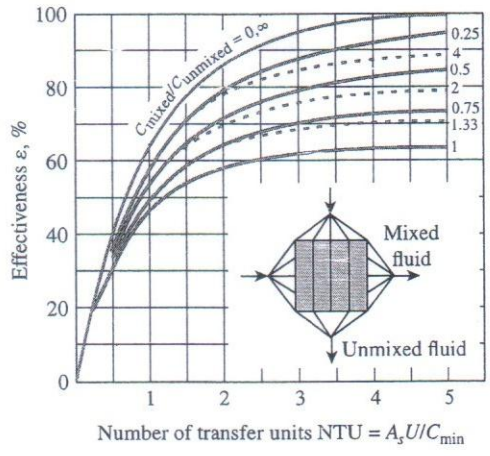
(*c*) One-shell pass and 2, 4, 6, … tube passes



(*d*) Two-shell passes and 4, 8, 12, … tube passes



(*e*) Cross-flow with both fluids unmixed



(*f*) Cross-flow with one fluid mixed and the other unmixed

FIGURE 11–27
Effectiveness for heat exchangers.

From Kays and London, 1984.

TABLE A–9

Properties of saturated water

Temp. T, °C	Saturation Pressure P_{sat}, kPa	Density ρ, kg/m³ Liquid	Density ρ, kg/m³ Vapor	Enthalpy of Vaporization h_{fg}, kJ/kg	Specific Heat c_p, J/kg·K Liquid	Specific Heat c_p, J/kg·K Vapor	Thermal Conductivity k, W/m·K Liquid	Thermal Conductivity k, W/m·K Vapor	Dynamic Viscosity μ, kg/m·s Liquid	Dynamic Viscosity μ, kg/m·s Vapor	Prandtl Number Pr Liquid	Prandtl Number Pr Vapor	Volume Expansion Coefficient β, 1/K Liquid
0.01	0.6113	999.8	0.0048	2501	4217	1854	0.561	0.0171	1.792×10^{-3}	0.922×10^{-5}	13.5	1.00	-0.068×10^{-3}
5	0.8721	999.9	0.0068	2490	4205	1857	0.571	0.0173	1.519×10^{-3}	0.934×10^{-5}	11.2	1.00	0.015×10^{-3}
10	1.2276	999.7	0.0094	2478	4194	1862	0.580	0.0176	1.307×10^{-3}	0.946×10^{-5}	9.45	1.00	0.733×10^{-3}
15	1.7051	999.1	0.0128	2466	4185	1863	0.589	0.0179	1.138×10^{-3}	0.959×10^{-5}	8.09	1.00	0.138×10^{-3}
20	2.339	998.0	0.0173	2454	4182	1867	0.598	0.0182	1.002×10^{-3}	0.973×10^{-5}	7.01	1.00	0.195×10^{-3}
25	3.169	997.0	0.0231	2442	4180	1870	0.607	0.0186	0.891×10^{-3}	0.987×10^{-5}	6.14	1.00	0.247×10^{-3}
30	4.246	996.0	0.0304	2431	4178	1875	0.615	0.0189	0.798×10^{-3}	1.001×10^{-5}	5.42	1.00	0.294×10^{-3}
35	5.628	994.0	0.0397	2419	4178	1880	0.623	0.0192	0.720×10^{-3}	1.016×10^{-5}	4.83	1.00	0.337×10^{-3}
40	7.384	992.1	0.0512	2407	4179	1885	0.631	0.0196	0.653×10^{-3}	1.031×10^{-5}	4.32	1.00	0.377×10^{-3}
45	9.593	990.1	0.0655	2395	4180	1892	0.637	0.0200	0.596×10^{-3}	1.046×10^{-5}	3.91	1.00	0.415×10^{-3}
50	12.35	988.1	0.0831	2383	4181	1900	0.644	0.0204	0.547×10^{-3}	1.062×10^{-5}	3.55	1.00	0.451×10^{-3}
55	15.76	985.2	0.1045	2371	4183	1908	0.649	0.0208	0.504×10^{-3}	1.077×10^{-5}	3.25	1.00	0.484×10^{-3}
60	19.94	983.3	0.1304	2359	4185	1916	0.654	0.0212	0.467×10^{-3}	1.093×10^{-5}	2.99	1.00	0.517×10^{-3}
65	25.03	980.4	0.1614	2346	4187	1926	0.659	0.0216	0.433×10^{-3}	1.110×10^{-5}	2.75	1.00	0.548×10^{-3}
70	31.19	977.5	0.1983	2334	4190	1936	0.663	0.0221	0.404×10^{-3}	1.126×10^{-5}	2.55	1.00	0.578×10^{-3}
75	38.58	974.7	0.2421	2321	4193	1948	0.667	0.0225	0.378×10^{-3}	1.142×10^{-5}	2.38	1.00	0.607×10^{-3}
80	47.39	971.8	0.2935	2309	4197	1962	0.670	0.0230	0.355×10^{-3}	1.159×10^{-5}	2.22	1.00	0.653×10^{-3}
85	57.83	968.1	0.3536	2296	4201	1977	0.673	0.0235	0.333×10^{-3}	1.176×10^{-5}	2.08	1.00	0.670×10^{-3}
90	70.14	965.3	0.4235	2283	4206	1993	0.675	0.0240	0.315×10^{-3}	1.193×10^{-5}	1.96	1.00	0.702×10^{-3}
95	84.55	961.5	0.5045	2270	4212	2010	0.677	0.0246	0.297×10^{-3}	1.210×10^{-5}	1.85	1.00	0.716×10^{-3}
100	101.33	957.9	0.5978	2257	4217	2029	0.679	0.0251	0.282×10^{-3}	1.227×10^{-5}	1.75	1.00	0.750×10^{-3}
110	143.27	950.6	0.8263	2230	4229	2071	0.682	0.0262	0.255×10^{-3}	1.261×10^{-5}	1.58	1.00	0.798×10^{-3}
120	198.53	943.4	1.121	2203	4244	2120	0.683	0.0275	0.232×10^{-3}	1.296×10^{-5}	1.44	1.00	0.858×10^{-3}
130	270.1	934.6	1.496	2174	4263	2177	0.684	0.0288	0.213×10^{-3}	1.330×10^{-5}	1.33	1.01	0.913×10^{-3}
140	361.3	921.7	1.965	2145	4286	2244	0.683	0.0301	0.197×10^{-3}	1.365×10^{-5}	1.24	1.02	0.970×10^{-3}
150	475.8	916.6	2.546	2114	4311	2314	0.682	0.0316	0.183×10^{-3}	1.399×10^{-5}	1.16	1.02	1.025×10^{-3}
160	617.8	907.4	3.256	2083	4340	2420	0.680	0.0331	0.170×10^{-3}	1.434×10^{-5}	1.09	1.05	1.145×10^{-3}
170	791.7	897.7	4.119	2050	4370	2490	0.677	0.0347	0.160×10^{-3}	1.468×10^{-5}	1.03	1.05	1.178×10^{-3}
180	1,002.1	887.3	5.153	2015	4410	2590	0.673	0.0364	0.150×10^{-3}	1.502×10^{-5}	0.983	1.07	1.210×10^{-3}
190	1,254.4	876.4	6.388	1979	4460	2710	0.669	0.0382	0.142×10^{-3}	1.537×10^{-5}	0.947	1.09	1.280×10^{-3}
200	1,553.8	864.3	7.852	1941	4500	2840	0.663	0.0401	0.134×10^{-3}	1.571×10^{-5}	0.910	1.11	1.350×10^{-3}
220	2,318	840.3	11.60	1859	4610	3110	0.650	0.0442	0.122×10^{-3}	1.641×10^{-5}	0.865	1.15	1.520×10^{-3}
240	3,344	813.7	16.73	1767	4760	3520	0.632	0.0487	0.111×10^{-3}	1.712×10^{-5}	0.836	1.24	1.720×10^{-3}
260	4,688	783.7	23.69	1663	4970	4070	0.609	0.0540	0.102×10^{-3}	1.788×10^{-5}	0.832	1.35	2.000×10^{-3}
280	6,412	750.8	33.15	1544	5280	4835	0.581	0.0605	0.094×10^{-3}	1.870×10^{-5}	0.854	1.49	2.380×10^{-3}
300	8,581	713.8	46.15	1405	5750	5980	0.548	0.0695	0.086×10^{-3}	1.965×10^{-5}	0.902	1.69	2.950×10^{-3}
320	11,274	667.1	64.57	1239	6540	7900	0.509	0.0836	0.078×10^{-3}	2.084×10^{-5}	1.00	1.97	
340	14,586	610.5	92.62	1028	8240	11,870	0.469	0.110	0.070×10^{-3}	2.255×10^{-5}	1.23	2.43	
360	18,651	528.3	144.0	720	14,690	25,800	0.427	0.178	0.060×10^{-3}	2.571×10^{-5}	2.06	3.73	
374.14	22,090	317.0	317.0	0	—	—	—	—	0.043×10^{-3}	4.313×10^{-5}			

Note 1: Kinematic viscosity ν and thermal diffusivity α can be calculated from their definitions, $\nu = \mu/\rho$ and $\alpha = k/\rho c_p = \nu/\text{Pr}$. The temperatures 0.01°C, 100°C, and 374.14°C are the triple-, boiling-, and critical-point temperatures of water, respectively. The properties listed above (except the vapor density) can be used at any pressure with negligible error except at temperatures near the critical-point value.

Note 2: The unit kJ/kg·°C for specific heat is equivalent to kJ/kg·K, and the unit W/m·°C for thermal conductivity is equivalent to W/m·K.

Source: Viscosity and thermal conductivity data are from J. V. Sengers and J. T. R. Watson, *Journal of Physical and Chemical Reference Data* 15 (1986), pp. 1291–1322. Other data are obtained from various sources or calculated.

TABLE A–15

Properties of air at 1 atm pressure

Temp. T, °C	Density ρ, kg/m³	Specific Heat c_p, J/kg·K	Thermal Conductivity k, W/m·K	Thermal Diffusivity α, m²/s	Dynamic Viscosity μ, kg/m·s	Kinematic Viscosity ν, m²/s	Prandtl Number Pr
−150	2.866	983	0.01171	4.158×10^{-6}	8.636×10^{-6}	3.013×10^{-6}	0.7246
−100	2.038	966	0.01582	8.036×10^{-6}	1.189×10^{-5}	5.837×10^{-6}	0.7263
−50	1.582	999	0.01979	1.252×10^{-5}	1.474×10^{-5}	9.319×10^{-6}	0.7440
−40	1.514	1002	0.02057	1.356×10^{-5}	1.527×10^{-5}	1.008×10^{-5}	0.7436
−30	1.451	1004	0.02134	1.465×10^{-5}	1.579×10^{-5}	1.087×10^{-5}	0.7425
−20	1.394	1005	0.02211	1.578×10^{-5}	1.630×10^{-5}	1.169×10^{-5}	0.7408
−10	1.341	1006	0.02288	1.696×10^{-5}	1.680×10^{-5}	1.252×10^{-5}	0.7387
0	1.292	1006	0.02364	1.818×10^{-5}	1.729×10^{-5}	1.338×10^{-5}	0.7362
5	1.269	1006	0.02401	1.880×10^{-5}	1.754×10^{-5}	1.382×10^{-5}	0.7350
10	1.246	1006	0.02439	1.944×10^{-5}	1.778×10^{-5}	1.426×10^{-5}	0.7336
15	1.225	1007	0.02476	2.009×10^{-5}	1.802×10^{-5}	1.470×10^{-5}	0.7323
20	1.204	1007	0.02514	2.074×10^{-5}	1.825×10^{-5}	1.516×10^{-5}	0.7309
25	1.184	1007	0.02551	2.141×10^{-5}	1.849×10^{-5}	1.562×10^{-5}	0.7296
30	1.164	1007	0.02588	2.208×10^{-5}	1.872×10^{-5}	1.608×10^{-5}	0.7282
35	1.145	1007	0.02625	2.277×10^{-5}	1.895×10^{-5}	1.655×10^{-5}	0.7268
40	1.127	1007	0.02662	2.346×10^{-5}	1.918×10^{-5}	1.702×10^{-5}	0.7255
45	1.109	1007	0.02699	2.416×10^{-5}	1.941×10^{-5}	1.750×10^{-5}	0.7241
50	1.092	1007	0.02735	2.487×10^{-5}	1.963×10^{-5}	1.798×10^{-5}	0.7228
60	1.059	1007	0.02808	2.632×10^{-5}	2.008×10^{-5}	1.896×10^{-5}	0.7202
70	1.028	1007	0.02881	2.780×10^{-5}	2.052×10^{-5}	1.995×10^{-5}	0.7177
80	0.9994	1008	0.02953	2.931×10^{-5}	2.096×10^{-5}	2.097×10^{-5}	0.7154
90	0.9718	1008	0.03024	3.086×10^{-5}	2.139×10^{-5}	2.201×10^{-5}	0.7132
100	0.9458	1009	0.03095	3.243×10^{-5}	2.181×10^{-5}	2.306×10^{-5}	0.7111
120	0.8977	1011	0.03235	3.565×10^{-5}	2.264×10^{-5}	2.522×10^{-5}	0.7073
140	0.8542	1013	0.03374	3.898×10^{-5}	2.345×10^{-5}	2.745×10^{-5}	0.7041
160	0.8148	1016	0.03511	4.241×10^{-5}	2.420×10^{-5}	2.975×10^{-5}	0.7014
180	0.7788	1019	0.03646	4.593×10^{-5}	2.504×10^{-5}	3.212×10^{-5}	0.6992
200	0.7459	1023	0.03779	4.954×10^{-5}	2.577×10^{-5}	3.455×10^{-5}	0.6974
250	0.6746	1033	0.04104	5.890×10^{-5}	2.760×10^{-5}	4.091×10^{-5}	0.6946
300	0.6158	1044	0.04418	6.871×10^{-5}	2.934×10^{-5}	4.765×10^{-5}	0.6935
350	0.5664	1056	0.04721	7.892×10^{-5}	3.101×10^{-5}	5.475×10^{-5}	0.6937
400	0.5243	1069	0.05015	8.951×10^{-5}	3.261×10^{-5}	6.219×10^{-5}	0.6948
450	0.4880	1081	0.05298	1.004×10^{-4}	3.415×10^{-5}	6.997×10^{-5}	0.6965
500	0.4565	1093	0.05572	1.117×10^{-4}	3.563×10^{-5}	7.806×10^{-5}	0.6986
600	0.4042	1115	0.06093	1.352×10^{-4}	3.846×10^{-5}	9.515×10^{-5}	0.7037
700	0.3627	1135	0.06581	1.598×10^{-4}	4.111×10^{-5}	1.133×10^{-4}	0.7092
800	0.3289	1153	0.07037	1.855×10^{-4}	4.362×10^{-5}	1.326×10^{-4}	0.7149
900	0.3008	1169	0.07465	2.122×10^{-4}	4.600×10^{-5}	1.529×10^{-4}	0.7206
1000	0.2772	1184	0.07868	2.398×10^{-4}	4.826×10^{-5}	1.741×10^{-4}	0.7260
1500	0.1990	1234	0.09599	3.908×10^{-4}	5.817×10^{-5}	2.922×10^{-4}	0.7478
2000	0.1553	1264	0.11113	5.664×10^{-4}	6.630×10^{-5}	4.270×10^{-4}	0.7539

Note: For ideal gases, the properties c_p, k, μ, and Pr are independent of pressure. The properties ρ, ν, and α at a pressure P (in atm) other than 1 atm are determined by multiplying the values of ρ at the given temperature by P and by dividing ν and α by P.

Source: Data generated from the EES software developed by S. A. Klein and F. L. Alvarado. Original sources: Keenan, Chao, Keyes, Gas Tables, Wiley, 1984; and Thermophysical Properties of Matter. Vol. 3: Thermal Conductivity, Y. S. Touloukian, P. E. Liley, S. C. Saxena, Vol. 11: Viscosity, Y. S. Touloukian, S. C. Saxena, and P. Hestermans, IFI/Plenun, NY, 1970, ISBN 0-306067020-8.

B.Sc. Engg. (ME)/HDME/ 6th Sem. 25 October 2019, Friday
BSc TE 2 year 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. 2018-19
Course No MCE 4621 / 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 full marks. Do not write on this question paper.

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1. a) Concisely write down any five recommendations for the design of a drive. Briefly explain Fourth Industrial Revolution after providing definitions of CNC and DNC machines. [12]
   b) Describe five major components of a lathe machine with appropriate sketches. Write down two advantages of Turret lathe over Conventional lathe machines. [13]

2. a) Describe any four types of milling with figures. Calculate the indexing required to cut 25 teeth on a spur gear blank. [12]

Plate No. 1	15	16	17	18	19	20
Plate No. 2	21	23	27	29	31	33
Plate No. 3	37	39	41	43	47	49

   b) Write short notes on any three of the following with appropriate figures: i) Compound die ii) Point angle iii) Discontinuous chip iv) Broaching [13]

3. a) Describe open and compound belt drives with figures and features. Write about a noise reduction method after mentioning about threshold hearing loss dBa value. [12]
   b) Could you differentiate clamps with jigs and fixtures? – explain briefly. Describe template jig and cam clamp with figures and features. [3+10]

4. a) Briefly explain compound gear train and describe any two types of gears with figures and features. [12]
   b) What do you understand by degree of freedom?- explain. Write briefly about three common materials in machine tool structure. [13]

5. a) Why is an electric motor preferred as a prime mover?-Mention any five reasons. A 0.5 Hp electric motor is able to move 3000 pounds of potting mixture into a storage box. The motor has a Service Factor (S.F.) of 1.2, and an output of 550 watts. Is this motor capable of performing this task? [12]
   b) In which industry or set up pneumatic drive is to be used?-explain with its advantages and limitations. Describe the working principle of a gear pump with figures. [13]

6. a) Describe any one type of conventional slideway with figures and features. Write down four differences between rolling and sliding guideways. [12]
   b) Why bearing is used in machine tools? Describe different parts of a ball bearing with neat figures. [13]

7. a) With a neat sketch, describe the working principle of surface grinding machine. Briefly write about two types of abrasives used in grinding wheels. [12]

   b) Describe the working procedure rack type gear shaping machine with figures. Write three main differences between gear shaping and hobbing machines. [13]

8. a) Write briefly about two things that non-conventional machining is supposed to solve. Describe working principle of Electrical Discharge Machining (EDM) with figures and its applications. [10]

   b) Draw a structural diagram and speed chart for a 16 speed gearbox for a head stock that could provide speed ranging from 50 rpm to 1600 rpm. The power is supplied by an electric motor of 10 KW running at 1440 rpm, through a V-belt drive with a speed reduction of 2:1 [15]

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B.Sc. Engg. (ME)/HDME (6th Semester) November 06, 2019.

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

Semester Final Examination — Summer Semester, A. Y. 2018-2019
Course No.: MCE 4627 — Time: 3 Hour
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) Explain in details the different design considerations for casting process and hence explain the gating system design used in casting. 15
   b) How the pouring time can be calculated for complete filling of the mould cavity? The flow rate of the liquid metal in the down sprue of a mould is 0.5 liter/sec. The cross sectional area of the top of the sprue=600 mm^2 and its length is 150 mm. What are should be used at the base of the sprue to avoid aspiration of the molten metal? 10

2. a) Write down with necessary diagram the constructional details and design features of a broaching tool. 15
   b) Explain the different types of broaching tool and their applications. 10

3. a) Explain in details with example the economic viability analysis and judging necessity for designing a jig and fixture. 12
   b) Write the different elements that need to be incorporated for the estimation of die costing and what should be the estimate format and terminology. 13

4. a) Write down and explain the different basic components of a die. What will be procedure and contents for the designing of a die? 17
   b) What are the different types of cutting dies are available? How the stripping force can be calculated? 08

5. a) Write down the different methods used for locations and explain with neat sketches the working mechanism of conical locators and Vee-locators. 10
   b) What are the differences between plate type jigs and box-type jigs? 8
   c) List the different types of clamping and write a short note on latch clamp. 7

6. a) How the morphological chart method and weighted objectives method can be used for the analysis of design solutions for a product? 12
   b) Explain briefly the design procedure of rational method and show its mapping on cross's model? 13

7. a) Determine the shear plane angle, cutting force component and resultant force on the tool for orthogonal cutting of a material with yield stress of 200 N/mm^2. Following are the machining parameters; Tool rake angle=15^0; uncut chip thickness=0.25 mm, chip width=2 mm; chip thickness ratio=.0.40; angle of friction=40^0. 10
   b) Explain briefly with necessary diagram the model of cutting process and hence explain the different types of chip in machining process. 10
   c) What do you mean by Tool signature? 05

8. a) Explain briefly with neat sketches the web construction and helix angle used in Twist drill. How does changing the helix angle effect the performance of a twist drill? 12
   b) Classify the different types of milling cutter and explain briefly the constructional details of a plain milling cutter? 13

BSc. Engg. (M)/HDME (6th Sem.)/DTE(2nd Sem.) 06 November 2019

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

SEMESTER FINAL EXAMINATION — SUMMER SEMESTER: 2018-2019

Course No: MCE-4653 — TIME : 3HRS

Course Name: Air Conditioning — 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) Write different factors affecting the thermal comfort. Explain thermal characteristics and responses of human body to temperature. (10)

   b) A 1.8 m tall man with a body mass of 70 kg performs light work (activity = 1.2 met) in an indoor environment. The indoor conditions are: DBT of 30°C, mean radiant temperature of 32°C, air velocity of 0.2 m/s. Assuming an average surface temperature of 34°C for the surface of the human being and light clothing, find the amount of evaporative heat transfer required so that the human being is at neutral equilibrium. (15)

2. a) Define Sol-air temperature and cooling load temperature difference. Explain the method of estimating heat gain due to infiltrated air. (10)

   b) An air conditioning room that stands on a well ventilated basement measures 3m wide, 3m high and 6m deep. One of the two 3m walls faces west contains a double glaze glass window of size 1.5m by 1.5m, mounted flush with the wall of no external shading. There are no heat gains through the walls other than the one facing west. For the following data, (15)

Inside condition: 25^0C DBT, 50% RH	SHG of glass ; 300 W/m^2
Outside conditions: 43^0C DBT, 24^0C WBT	SC of glass: 0.86
U-value for wall: 1.78 W/m^{2}K	Occupancy: 4 (90W sensible heat/person and 40W latent heat/person)
U-value for roof: 1.316 W/m^{2}K	Lighting load: 33 W/m^2 of floor area
U-value for floor: 1.2 W/m^{2}K	Appliance load: 600W sensible and 300W latent
CLTD for wall: 25^0C	Infiltration: 0.5 ACH
CLTD for roof: 30^0C	Barometric pressure: 1 atm
U-value for glass: 3.12 W/m^{2}K	

   Calculate the sensible, latent and total heat gain in the room. What will be the required cooling capacity?

3. a) Explain briefly the importance of cooling load estimation. What are the different components of heat gain to the air conditioning space? (10)

   b) An air-conditioning system is to be designed for a restaurant with the following data: (15)
   Outside design conditions: 40^0C DBT, 28^0C WBT
   Inside design condition: 25^0C DBT, 50% RH
   Solar heat gains through walls, roof, and floor =5.87 kW
   Solar heat gain through glass = 5.52 kW
   Occupants = 25
   Sensible heat gain person =58 W
   Latent heat gain per person = 58 W
   Internal lighting load = 15 lamps of 100 W and 10 fluorescent tube of 80 W
   Sensible heat gain from other sources = 11.63 kW
   Infiltrated air = 15 m^3/min
   If 25% fresh air and 75%recirculated air is mixed and passed through the conditioner coil, find
   (a) The amount of total air required in m^3/h ;
   (b) The dew point temperature of the coil;
   (c) The condition of the supply air to the room and

(d) The capacity of the conditioning plant.

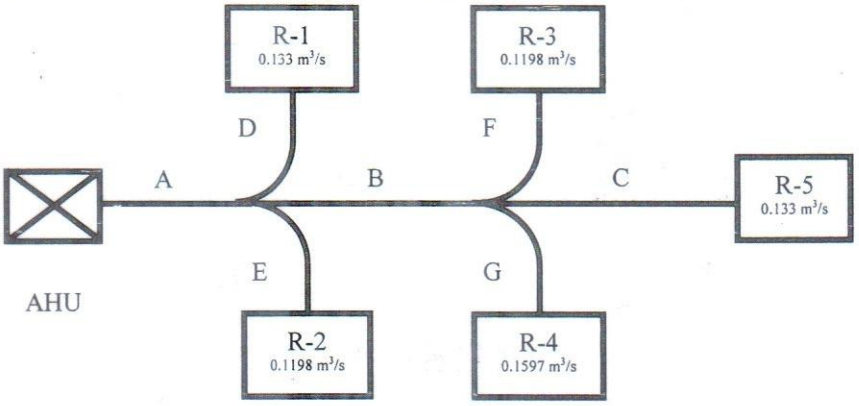
Assume the by-pass factor as 0.2.

Draw the schematic diagram of the system and show the processes on psychometric chart.

4. a) Explain the method of estimating solar radiation through clear plastic glass. What do you understand by internal and external shading of the glass window and explain how they impart in the calculation of cooling load for a conditioned space. (15)

b) Explain characteristics of one-dimensional steady heat transfer through building wall. Show diagram with resistance network. Write equations for all relevant heat transfer quantities. (10)

5. a) The following figure shows typical duct layout of a residential building. The conditioned air is supplied to five different condition spaces at the required flow rate as shown. The length of the duct run A=B=C=6m and D=E=F=G= 4m. Design the rectangular duct dimensions of reasonable aspect ratio using equal friction method. Take the velocity of air in the main duct (A) as 5 m/s. Assume a dynamic loss co-efficient of 0.3 for upstream to downstream and 0.8 for upstream to branch and for elbow. The dynamic loss coefficient for the outlet may be taken as 1.0. Find also the required FTP for each case and the amount of dampering.

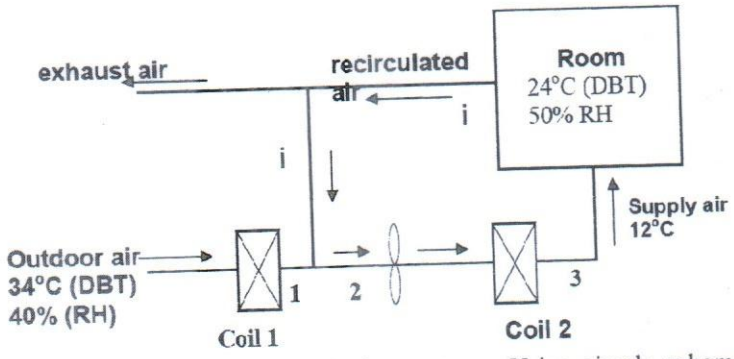


6. (a) Explain with neat sketch the method of estimating solar radiation through fenestration. What are the different aspects of solar radiation in the study of air-conditioning system? (10)

(b) A building has its north, west facing walls and the roof exposed to sun. The dimensions of the building are 12 m X 12 m X 5 m (W X L X H). The U-value of the walls are 0.5 $W/m^2.K$, while it is 0.4 $W/m^2.K$ for the roof. There are no windows on north and west walls, and the other two walls are exposed to air conditioned spaces. The outside design temperature is 41°C while the indoor is maintained at 25°C, and the average temperature for the design day is 31°C. Calculate heat transfer rate to the building at 5 P.M., 6 P.M and & 7 P.M. Assume the walls are of D-Type and the roof is of Type 5. (15)

7. (a) State different Fan's laws with their mathematical expressions used for air-conditioning application. (10)

(b) A room is air conditioned by a system that maintains 24 ^{0}C dry bulb and 50 % RH inside, when the outside conditions are 34^{0}C dry bulb and 40% RH. The room sensible and latent heat gains are 60 kW and 12 kW respectively. As shown in the figure below, The outside fresh air first flows over a first cooler coil and is reduced to state 1 of 10^{0}C dry bulb and a relative humidity of 85%. It is then mixed with re-circulated air, the mixture (state 2) being handled by a fan, passed over a second cooler coil and sensibly cooled to 12^{0}C dry bulb (state 3). The air is then delivered to the room. If the outside fresh air is used for dealing with the whole of the room latent heat gain and if the effects of fan power and duct heat gains are ignored, find: i) mass flow rates of outside fresh air and supply air; ii) DBT and enthalpy of the air handled by the fan (state 2); and iii) required cooling capacity of first cooler coil and second sensible cooler coil. (15)



8. (a) Make a list of different types of air-conditioning systems. Using simple schematic diagram elaborate working principle of window air conditioning system in view of technical aspects. (10)

(b) Draw simple diagram of a central air conditioning system using air handling unit (AHU). (15)

Equations: $h = 1.005t + W(2501 + 1.88t)$ $A_{Du} = 0.202\, m^{0.425} h^{0.725}$; $Q_c = 14.8\, V^{0.5}(t_b - t)$; $Q_r = 11.603\,(t_b - t_s)$

$$\Delta p_f = \frac{0.022243\, \dot{Q}_{air}^{1.852}\, L}{D^{4.973}}$$

Roof type	Mass per unit area, kg/m²	Heat capacity, kJ/m².K	Solar Time, h													
			07	08	09	10	11	12	13	14	15	16	17	18	19	20
3	90	90	-2	1	5	11	18	25	31	36	39	40	40	37	32	25
4	150	120	1	0	2	4	8	13	18	24	29	33	35	36	35	32
5	250	230	4	4	6	8	11	15	18	22	25	28	29	30	29	27
6	365	330	9	8	7	8	8	10	12	15	18	20	22	24	25	26

Description of Roof types:

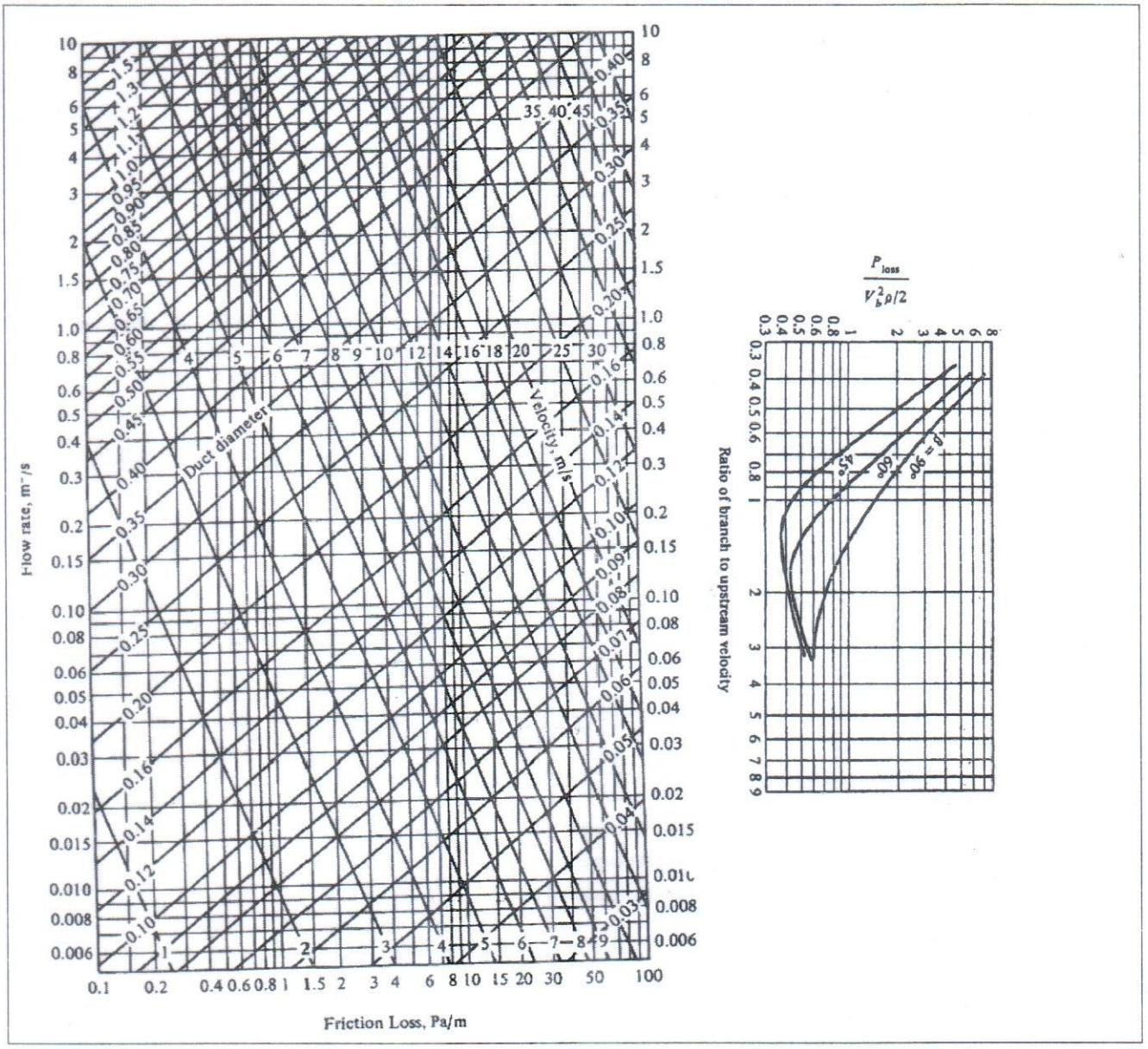
Type 3: 100 mm thick, lightweight concrete

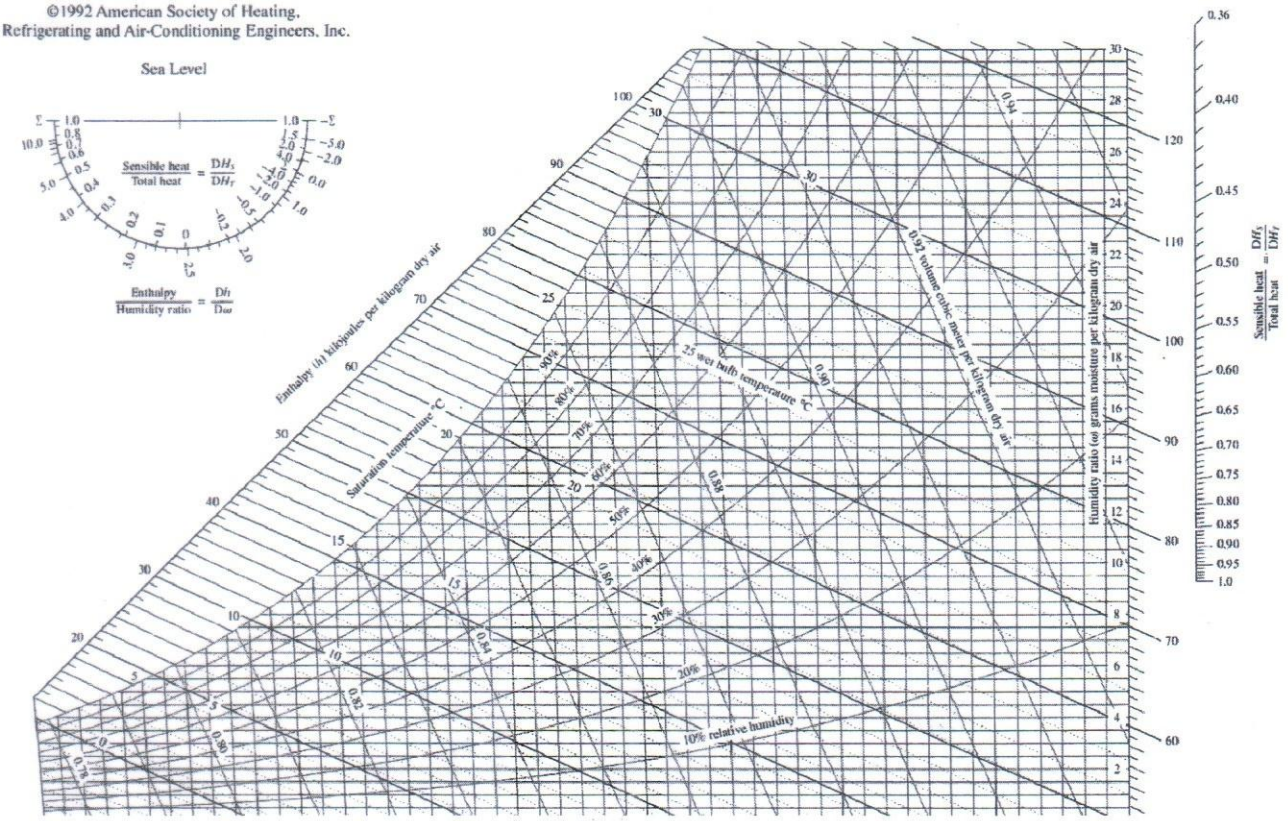
Type 4: 150 mm thick, lightweight concrete

Type 5: 100 mm thick, heavyweight concrete

Type 6: Roof terrace systems

Solar Time,h	Orientation							
	N	NE	E	SE	S	SW	W	NW
7	3	4	5	5	4	6	7	6
8	3	4	5	5	4	5	6	5
9	3	6	7	5	3	5	5	4
10	3	8	10	7	3	4	5	4
11	4	10	13	10	4	4	5	4
12	4	11	15	12	5	5	5	4
13	5	12	17	14	7	6	6	5
14	6	13	18	16	9	7	6	6
15	6	13	18	17	11	9	8	7
16	7	13	18	18	13	12	10	8
17	8	14	18	18	15	15	13	10
18	9	14	18	18	16	18	17	12
19	10	14	17	17	16	20	20	15
20	11	13	17	17	16	21	22	17
$CLTD_{max}$	11	14	18	18	16	21	23	18


Flow rate, m³/s
Friction Loss, Pa/m
Duct diameter
Velocity, m/s
$\frac{P_{loss}}{V_b^2\rho/2}$
Ratio of branch to upstream velocity
θ = 90°
60°
45°



Saturated water—Temperature table

Temp., T °C	Sat. press., P_{sat} kPa	Specific volume, m³/kg: Sat. liquid, v_f	Specific volume, m³/kg: Sat. vapor, v_g	Internal energy, kJ/kg: Sat. liquid, u_f	Internal energy, kJ/kg: Evap., u_{fg}	Internal energy, kJ/kg: Sat. vapor, u_g	Enthalpy, kJ/kg: Sat. liquid, h_f	Enthalpy, kJ/kg: Evap., h_{fg}	Enthalpy, kJ/kg: Sat. vapor, h_g	Entropy, kJ/kg·K: Sat. liquid, s_f	Entropy, kJ/kg·K: Evap., s_{fg}	Entropy, kJ/kg·K: Sat. vapor, s_g
0.01	0.6117	0.001000	206.00	0.000	2374.9	2374.9	0.001	2500.9	2500.9	0.0000	9.1556	9.1556
5	0.8725	0.001000	147.03	21.019	2360.8	2381.8	21.020	2489.1	2510.1	0.0763	8.9487	9.0249
10	1.2281	0.001000	106.32	42.020	2346.6	2388.7	42.022	2477.2	2519.2	0.1511	8.7488	8.8999
15	1.7057	0.001001	77.885	62.980	2332.5	2395.5	62.982	2465.4	2528.3	0.2245	8.5559	8.7803
20	2.3392	0.001002	57.762	83.913	2318.4	2402.3	83.915	2453.5	2537.4	0.2965	8.3696	8.6661
25	3.1698	0.001003	43.340	104.83	2304.3	2409.1	104.83	2441.7	2546.5	0.3672	8.1895	8.5567
30	4.2469	0.001004	32.879	125.73	2290.2	2415.9	125.74	2429.8	2555.6	0.4368	8.0152	8.4520
35	5.6291	0.001006	25.205	146.63	2276.0	2422.7	146.64	2417.9	2564.6	0.5051	7.8466	8.3517
40	7.3851	0.001008	19.515	167.53	2261.9	2429.4	167.53	2406.0	2573.5	0.5724	7.6832	8.2556
45	9.5953	0.001010	15.251	188.43	2247.7	2436.1	188.44	2394.0	2582.4	0.6386	7.5247	8.1633
50	12.352	0.001012	12.026	209.33	2233.4	2442.7	209.34	2382.0	2591.3	0.7038	7.3710	8.0748
55	15.763	0.001015	9.5639	230.24	2219.1	2449.3	230.26	2369.8	2600.1	0.7680	7.2218	7.9898
60	19.947	0.001017	7.6670	251.16	2204.7	2455.9	251.18	2357.7	2608.8	0.8313	7.0769	7.9082
65	25.043	0.001020	6.1935	272.09	2190.3	2462.4	272.12	2345.4	2617.5	0.8937	6.9360	7.8296
70	31.202	0.001023	5.0396	293.04	2175.8	2468.9	293.07	2333.0	2626.1	0.9551	6.7989	7.7540
75	38.597	0.001026	4.1291	313.99	2161.3	2475.3	314.03	2320.6	2634.6	1.0158	6.6655	7.6812
80	47.416	0.001029	3.4053	334.97	2146.6	2481.6	335.02	2308.0	2643.0	1.0756	6.5355	7.6111
85	57.868	0.001032	2.8261	355.96	2131.9	2487.8	356.02	2295.3	2651.4	1.1346	6.4089	7.5435
90	70.183	0.001036	2.3593	376.97	2117.0	2494.0	377.04	2282.5	2659.6	1.1929	6.2853	7.4782
95	84.609	0.001040	1.9808	398.00	2102.0	2500.1	398.09	2269.6	2667.6	1.2504	6.1647	7.4151
100	101.42	0.001043	1.6720	419.06	2087.0	2506.0	419.17	2256.4	2675.6	1.3072	6.0470	7.3542

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

Final Semester Examination — Summer Semester, A.Y. 2018-2019
Course No. MCE 4663 — TIME : 3 Hours
Course Title: Automatic Control Engineering — Full Marks : 150

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

1. Consider the process shown in Fig. 1. Find out the relationship between the level of the liquid in the tank and changes in the inlet valve opening. 25

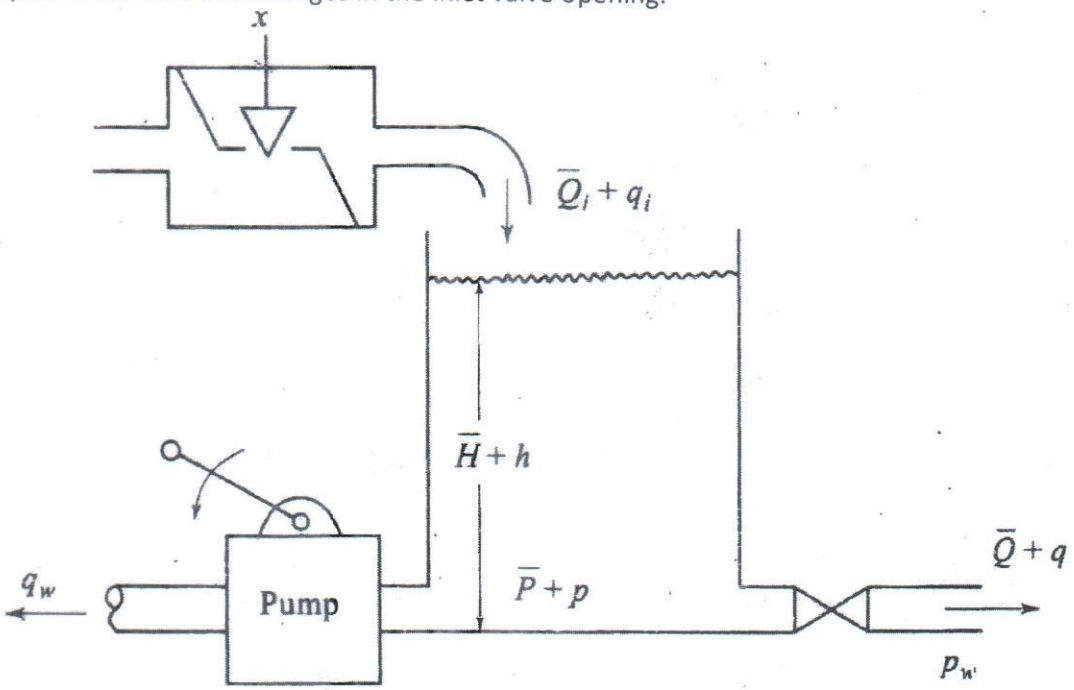


Fig. - 1

2. a) Using the example of rotary movement of a cylindrical mass with a flexible shaft explain the characteristics of a second order transfer function. What are the physical meanings of the characteristics? 15

b) What do you mean by math-modeling? Using the standard sequence of modeling (State variable method) find the relationship between the output displacement ***x*** and input force ***F*** (Fig. - 2). 10

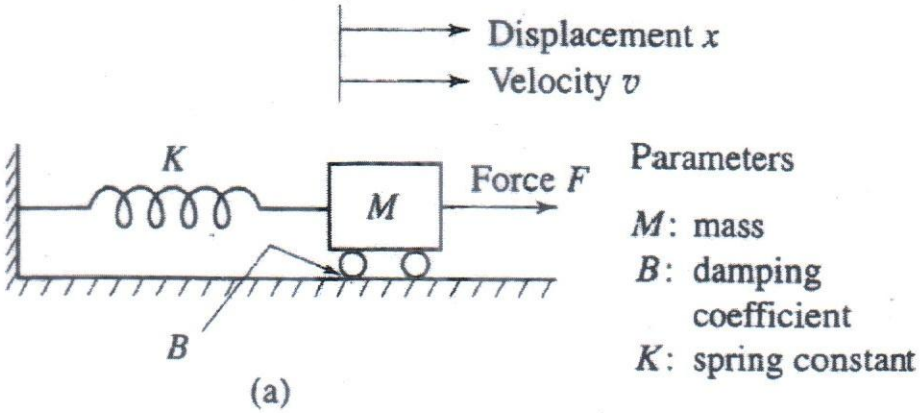


Fig. - 2

3. What are the Routh criterion of stability? Using Routh Array find out the number of poles in Right Hand Plane (RHP), Left Hand Plane (LHP) and on jw axis. 25

$(i)\ s^6 + 4s^5 + 3s^4 + 2s^3 + s^2 + 4s + 4 = 0$

$(ii)\ s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$

$(iii)\ s^5 + 3s^4 + 2s^3 + 6s^2 + 6s + 9 = 0$

$(iv)\ s^4 + 2s^3 + 8s^2 + 4s + 3 = 0$

4. a) Simplify the following Block Diagram showing in Fig. - 3 20

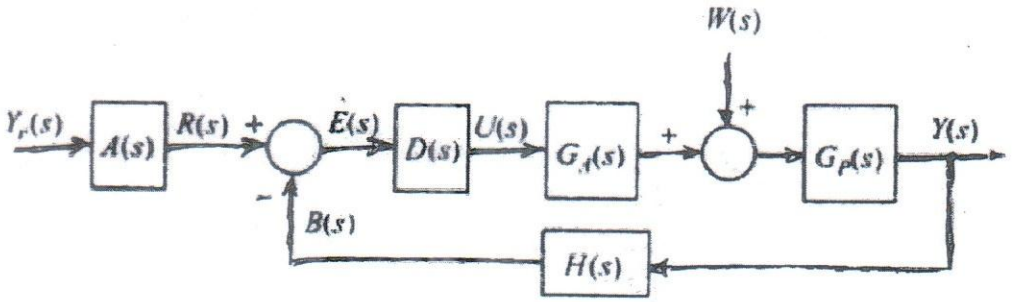


Fig. - 3

If the output is

$Y(s) = M(s).R(s) + M_w(s).W(s)$

Find the transfer functions M(s) and $M_w(s)$.

b) Describe different models of disturbances and write their transfer function. Why they are called standerd test signals. 5

5. a) Consider a close loop system showing in Fig.-4. A PI controller controls a second order plant. Determine the range of K_c for which the system is stable i.e. $R_e(s) < 0$. 12

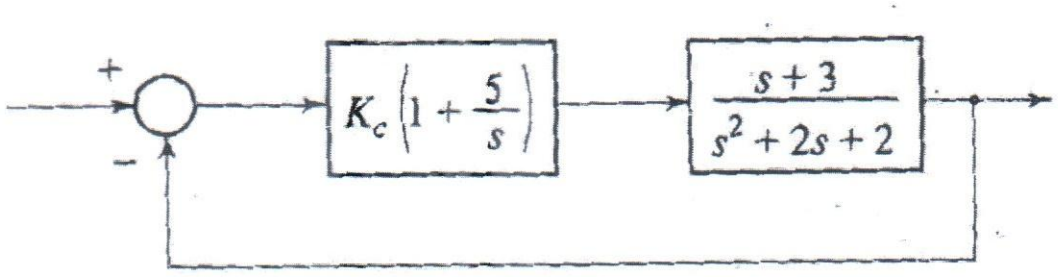


Fig. - 4

b) What should be done if the condition is given that $R_e(s) < -2$. 13

6. Consider the control system in Fig. 5 in which a proportional controller is employed. A specification on the control system is that the steady state error must be less than two percent for constant input. 25

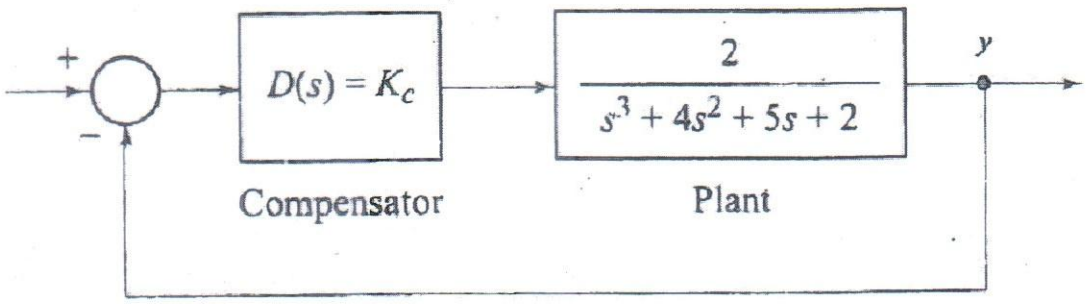


Fig. - 5

a) Find the K_c that satisfies the specification
b) If the steady state criterion cannot be met with a proportional compensator use a dynamic compensator $D(s) = 3 + k_I/s$. Find the range of K_I that satisfies the requirement of steady state error.

7. a) Controlled plant of a unity feedback system is 10

$$G(s) = \frac{k}{s(s+10)(s+20)}$$

Determine the value of K so that damping ratio of the dominant close loop poles is 0.6. For the value of K, determine the velocity constant K_v.

b) It is desired to increase K_v by a factor of 10. It is also desired to keep the damping ratio of the dominant close loop poles at 0.6. A small change in undamped natural frequency of the dominant close loop poles is permissible. Design a cascade compensator to realise the objective. 15

8. The controlled plant of a unity feedback system is 25

$$G(s) = \frac{k}{s(s+1)(s+5)}$$

It is desired to compensate the system so as to meet the following transient response specifications:

Damping ratio of the dominant root = 0.45

Undamped natural frequency of dominant poles = 3.5 rad/sec

Velocity error constant = 30 sec^{-1}

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

Semester Final Examination — Summer Semester : **A.Y. 2018-2019**
Course Code: **MCE 4671** — Time : **3 Hours**
Course Title: **Fossil Fuel Engineering** — Full Marks : **150**

There are 08 (Eight) Questions. Answer any 06 (Six) of them.
Do not write on the Question Paper. Figures in the Margin indicate the Full Marks.

1	a)	Define Fossil Fuel. Distinguish between primary and secondary fuels with examples.	(7)
	b)	Explain about the combustible elements that are present in fuel.	(8)
	c)	Discuss about the fossil fuel reserve around the world.	(10)
2	a)	Define Coal mining. Write down the classification of coal mining methods.	(5)
	b)	Explain different coal mining technologies in detail. Draw schematic diagrams where necessary.	(20)
3	a)	Explain the surface occurrence of petroleum in detail with sketches.	(18)
	b)	Write a short note on reservoir fluids.	(7)
4	a)	What is petroleum exploration? Discuss different procedures for petroleum exploration.	(15)
	b)	What is fractional distillation of crude oil? Explain with simple sketches.	(10)
5	a)	Define petroleum drilling operation. Discuss the classification of drill holes.	(8)
	b)	Briefly explain the advantages of mechanical drilling.	(7)
	c)	Describe the rotary drilling operations with different systems.	(10)
6	a)	What is gaseous fuel? Discuss the important features of gaseous fuel.	(7)
	b)	Discuss different types of gaseous fuels with their source, composition and uses.	(18)
7	a)	Deduce a formula for finding minimum amount of air required for complete combustion of a solid fuel. The fuel is composed of Carbon, Hydrogen, Sulphur and Oxygen.	(10)
	b)	In an oil fired boiler the fuel had an analysis by mass: Carbon 80%, Hydrogen 12.8%, Sulphur 4.5%, oxygen 1.9%, remainder incombustible. Calculate per kg of fuel (i) theoretical air supply and (ii) mass of products of combustion.	(15)
8	a)	Write a short note on liquefied petroleum gas (LPG) and liquefied natural gas (LNG).	(10)
	b)	Define refractories. Describe different types of refractories and their uses.	(15)

***

HDME 6th Semester 6 November (Morning)

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

Semester Final Examination Summer Semester, A.Y. 2018-2019
Course No: MCE 4685 Time : 3 Hours Course
Course Title:Automotive Technology (II) Full Marks : 150

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

1	a)	Briefly explain different arrangements of engine in automobiles. Write the significance of each arrangement.	10
	b)	Write down the objectives of differential gear box installation in vehicles. Explain the working principle of planetary gear system in auto transmission using simple schematic diagram.	15
2	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
3	a)	What is antilock braking system? Why this ABS system is preferred over conventional braking system?	8
	b)	Write the function of brakes in automobiles. Provide detailed explanation for working principle of Drum and Disc brakes with proper labelled diagrams.	17
4	a)	Draw as relay as used in a simple headlight circuit of an automobile vehicle and explain the basic operation of the relay.	10
	b)	Describe different types of lamps and light in lighting system of a car.	8
	c)	Draw a lighting circuit incorporating fuse and relays used in automobile vehicle.	7
5	a)	What is an ECU? What are the different types of ECU available?	10
	b)	Briefly describe the different types of sensor that is used in an automobile vehicle.	15
6	a)	Demonstrate the importance of installing stator in TC?	7
	b)	Elaborate the Transmission power flow of five speed manual transmission with labeled schematic diagrams.	18

7	a)	Write the principle and main components of hydraulic brake system. Explain its operational principle in detail with labelled diagrams.	13
	b)	Briefly explain mechanism of engagement and disengagement of clutch system in automobiles.	12
8	a)	What are the main components of a suspension system? Explain how shock is absorbed by the suspension system in automobiles.	15
	b)	Why is leaf spring installed in heavy vehicles? Explain working of this type of suspension system.	10

HDME 6th Sem October 31, 2019

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Semester Final Examination
Course No.: MCE 4687
Course Title: Automobile Maintenance Engineering (II)

Summer Semester, A. Y. 2018-2019
Time: 3 Hours
Full Marks: 150

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

Marks in the margin indicate full marks.
Do not write on this question paper.

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1. a) Provide the necessary steps to be taken for dismantling and replacing a MacPherson Strut. Explain them briefly. (15)
   b) Write the steps to be followed while changing the Automatic transmission fluid and filter. (10)
2. Explain the procedures for inspecting the following systems, (25)
   I. Rack and Pinion Steering System
   II. Brake line and brake pedal of hydraulic brake system.
   III. Master cylinder of Hydraulic brake system.
3. Write a comprehensive note on the following clutch problems diagnosis, (25)
   I. Slippage
   II. Chatter
   III. Drag and Binding
   IV. Pedal Pulsation
   V. Vibration
4. a) Write down the thorough explanation for diagnosis and inspection of CV joints. Briefly explain the maintenance steps for servicing of U-joints. (12)
   b) How the compressor's clutch service is performed. Briefly explain the procedure adopted for clutch and pulley replacement. (13)
5. a) Write the crucial steps for diagnosing a suspension system of an automobile. Explain. (12)
   b) Demonstrate the following angles with labelled diagrams and explain why their accuracy plays grander role in acquiring accuracy of steering system's alignment (13)
      I. Caster
      II. Camber
      III. Toe
6. a) Write the safety precautions needs to be taken before proper examination of ABS. Explain. (13)
   b) Provide the necessary steps for checking the solenoidal leaks in the hydraulic modulator. (12)
7. a) Write the possible causes and remedies of following problems appear in Transmission/Transaxle of automobile. (18)
      I. Gear clash when shifting from one gear to another.
      II. Does not shift into one gear.
      III. Slips out of gear.
      IV. Transmission/Transaxle shift hard
   b) Write a procedure for removing and installing a steering wheel. (7)
8. Write a complete note on the maintenance of following components of AC, (25)
   I. Evaporator
   II. Condenser

BSc. Eng. (M)/ HDME/ 6th Sem.
BScTE(2-Yr) 2nd Sem

04 November 2019

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING (MPE)

Semester Final Examination — Summer Semester A.Y. 2018-2019
Course Code: MCE 4609/ 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.
Don't write on this question paper.

---

1. Fig. 1(a) shows a hand operated crimping Tool, during a crimping operation. The tool develops a crimp force of 2000 lb (8896 N) at closure in the position shown. Fig. 1(b) shows the elements of the crimping-tool assembly separated and drawn as free-body diagrams with all forces applied to each element, neglecting their weights as being insignificant compared to the applied forces. The geometry and loading can be known from Table 1. The thickness of link-1 is 0.313 in, of links 2 and 3 is 0.125 in and of link 4, 0.187 in. All material is 1095 steel with E = 30 Mpsi and S_y=83000 psi. Determine the stresses and deflections at critical points in the crimping tool. $(16\frac{2}{3})$

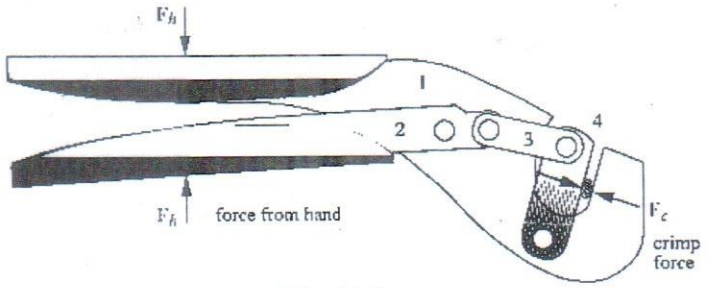


Fig. 1(a)

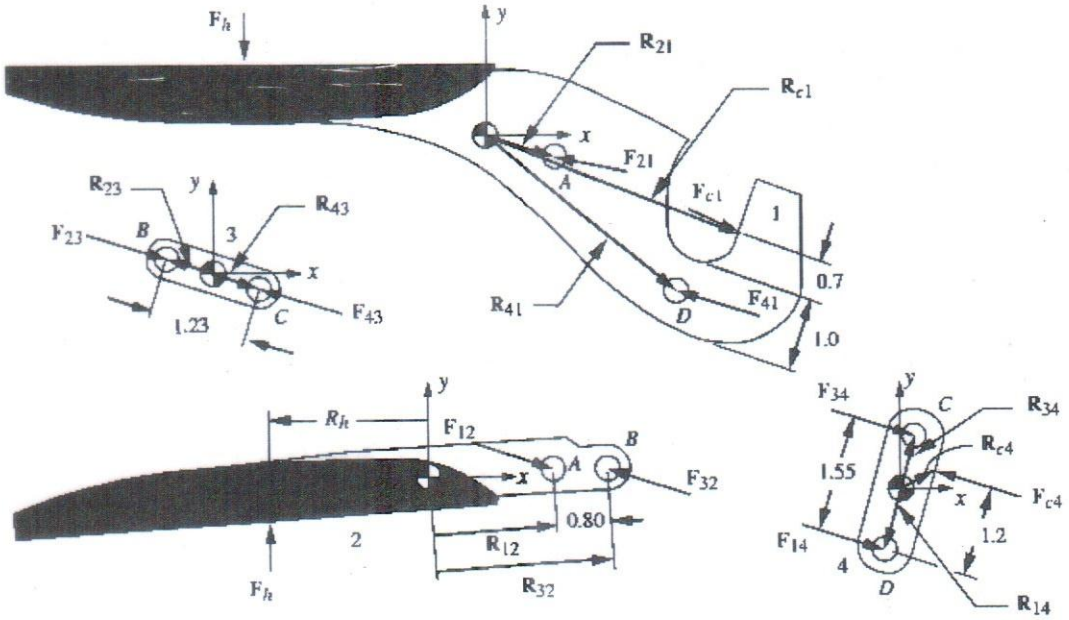


Fig. 1(b)

Variable	Value	Unit
F_{c4x}	−1 956.30	lb
F_{c4y}	415.82	lb
R_{c4x}	0.45	in
R_{c4y}	0.34	in
R_{12x}	1.40	in
R_{12y}	0.05	in
R_{32x}	2.20	in
R_{32y}	0.08	in
R_h	−4.40	in
R_{23x}	−0.60	in
R_{23y}	0.13	in
R_{43x}	0.60	in
R_{43y}	−0.13	in
R_{14x}	−0.16	in
R_{14y}	−0.76	in
R_{34x}	0.16	in
R_{34y}	0.76	in

Variable	Value	Unit
F_h	53.1	lb
F_{12x}	1 513.6	lb
F_{12y}	−381.0	lb
F_{32x}	−1 513.6	lb
F_{32y}	327.9	lb
F_{43x}	−1 513.6	lb
F_{43y}	327.9	lb
F_{23x}	1 513.6	lb
F_{23y}	−327.9	lb
F_{34x}	1 513.6	lb
F_{34y}	−327.9	lb
F_{14x}	442.7	lb
F_{14y}	−87.9	lb
F_{21x}	−1 513.6	lb
F_{21y}	381.0	lb
F_{41x}	−442.7	lb
F_{41y}	87.9	lb

Table 1

2. The cantilevered bar in the Fig. 2 is statically loaded with F_x =350 lbf, F_y = 200 lbf, and F_z = -100 lbf. The bar is made from a Brittle material and requiring the inclusion of stress concentration in the fillet radius. $(16\frac{2}{3})$

a) Determine the precise location of the critical stress element at the cross section at A.
b) Sketch the critical stress element and determine magnitudes and directions for all stresses acting on it. (Transverse shear may be neglected if you can justify this decision.)
c) For the critical stress element, determine the principal stresses and the maximum shear stress.

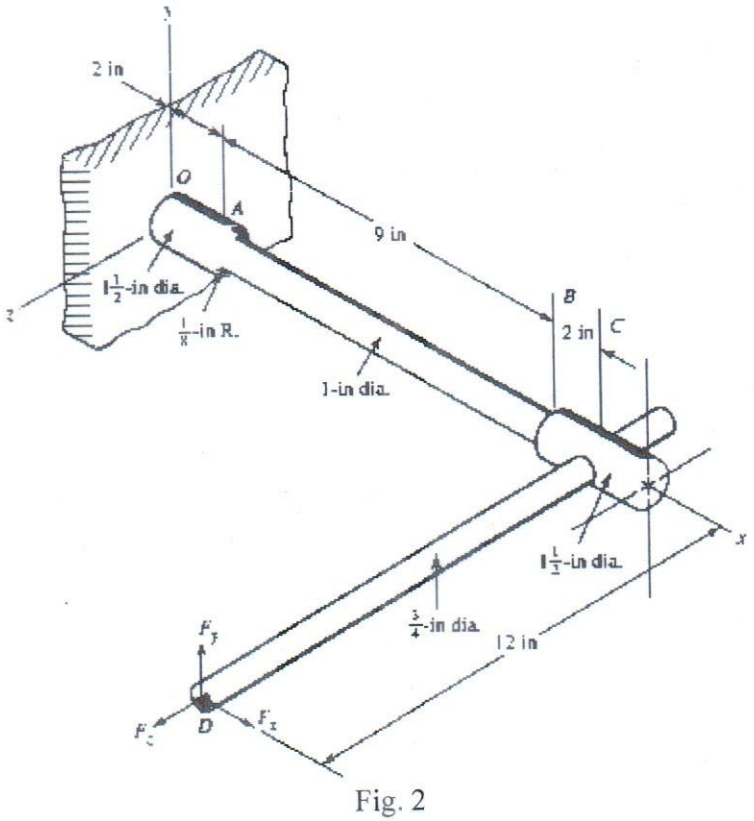


Fig. 2

3. The steel eyebolt shown in the Fig. 3 is loaded with a force $F = 400\ N$. The bolt is formed from wire of diameter $d = 7.5\ mm$ to a radius $R_i = 10\ mm$ in the eye and at the shank. Estimate the stresses at the inner and outer surfaces at section B-B. Also Plot the distribution of stresses across that section. $(16\frac{2}{3})$

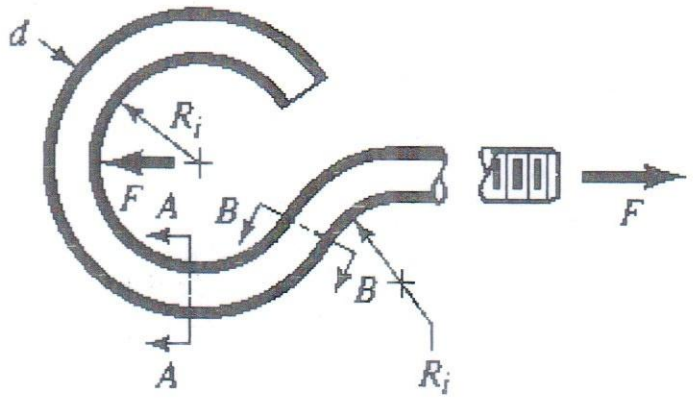


Fig. 3

4. For the wire form of diameter d shown in Fig. 4, determine the deflection of *point B* in the direction of the applied force F. $(16\frac{2}{3})$

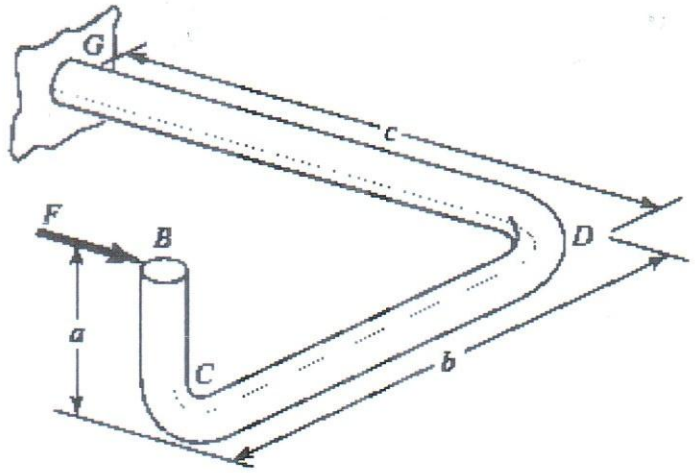


Fig. 4

5. a) Discuss the failure theories of Brittle materials $(7\frac{2}{3})$

b) A column with one end fixed and other end free is to be made of AISI 1030 HR steel. The column cross sectional area is to be 600mm^2 and its length is 2.5m. Find the critical Buckling load for the following cross-sections: (9)

a) A solid round bar
b) A solid square bar

6. A countershaft carrying two V-belt pulleys is shown in the Fig. 5. Pulley A receives power from a motor through a belt with the belt tensions shown. The power is transmitted through the shaft and delivered to the belt on pulley B. Assume the belt tension on the loose side at B is 15 percent of the tension on the tight side. For the steel countershaft, find the deflection and slope of the shaft at point A. Use superposition with the deflection equations in Table A–9 or *Singularity functions*. Assume the bearings constitute simple supports. $(16\frac{2}{3})$

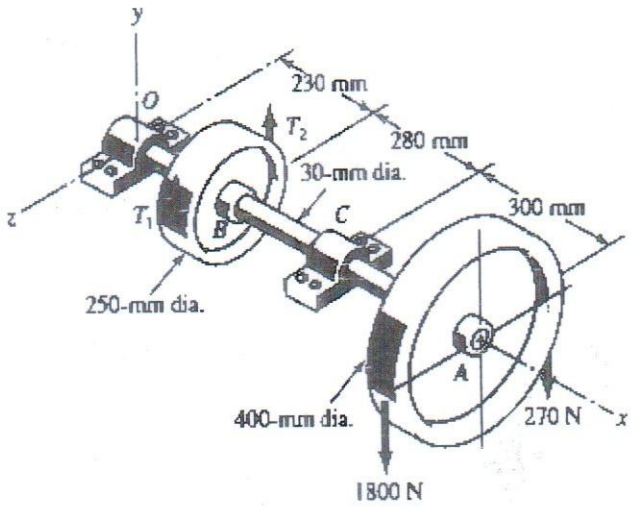


Fig. 5

7. This bar in Fig. 5 is made of. ASTM grade 20 cast iron, and is loaded by the forces F =0.55 kN, P =4.0 kN, and T = 25 N m. $(16\frac{2}{3})$
(a) Coulomb-Mohr failure model.
(b) Modified Mohr failure model.
(c) Maximum Normal Stress failure model.

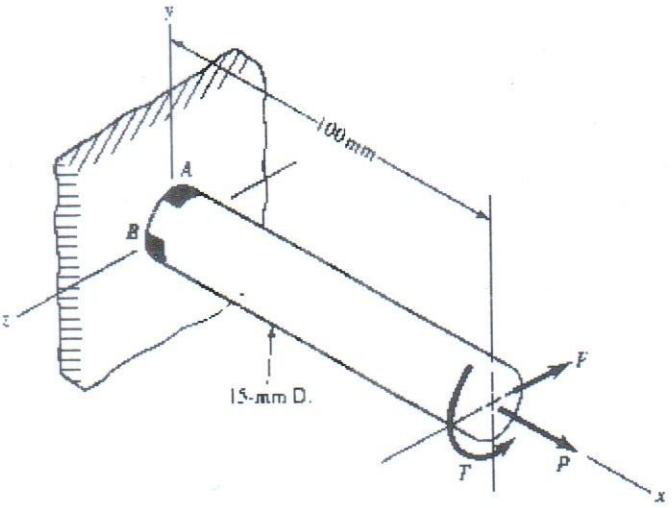


Fig. 5

8. The rotating shaft shown in the Fig. 6 is machined from AISI 1020 CD steel. It is subjected to a force of F = 6 kN. Find the minimum factor of safety for fatigue based on infinite life. If the life is not infinite, estimate the number of cycles. $(16\frac{2}{3})$

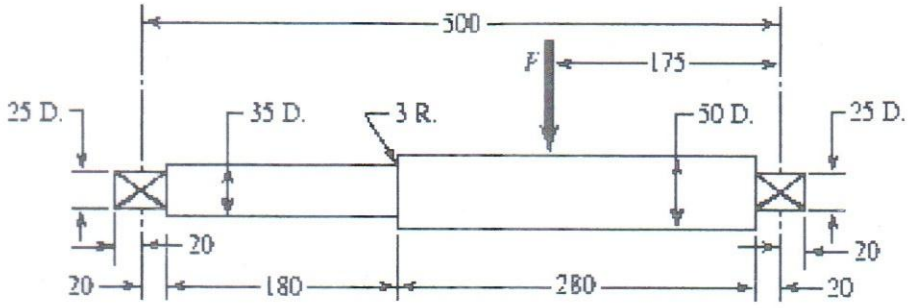
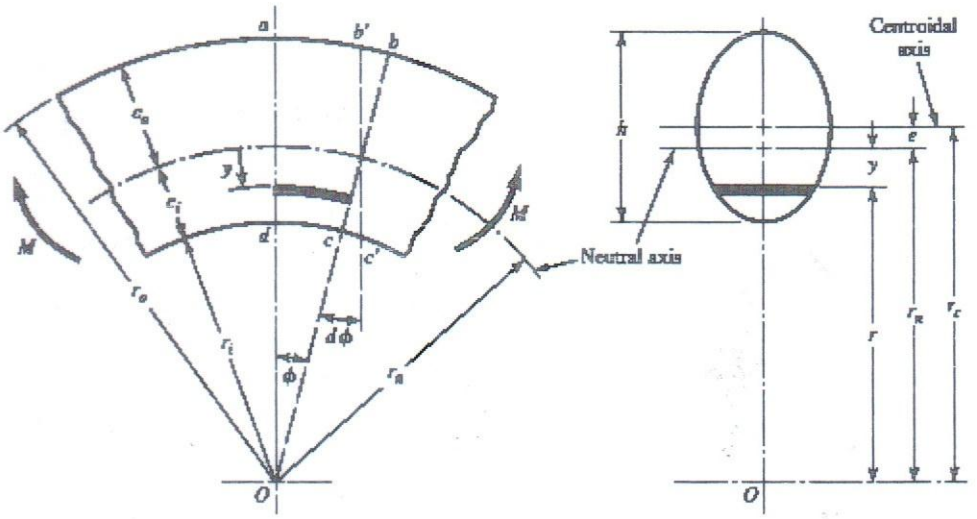


Fig. 6

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

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



$$\frac{P_{cr}}{A} = \frac{C\pi^2 E}{(l/k)^2}$$

$$\left(\frac{l}{k}\right)_1 = \left(\frac{2\pi^2 CE}{S_y}\right)^{1/2}$$

$$\frac{P_{cr}}{A} = a - b\left(\frac{l}{k}\right)^2$$

$a = S_y$

$$b = \left(\frac{S_y}{2\pi}\right)^2 \frac{1}{CE}$$

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

$$\delta_i = \frac{\partial U}{\partial F_i} = \int \frac{1}{AE}\left(F\frac{\partial F}{\partial F_i}\right)dx \qquad \text{tension and compression}$$

$$\theta_i = \frac{\partial U}{\partial M_i} = \int \frac{1}{GJ}\left(T\frac{\partial T}{\partial M_i}\right)dx \qquad \text{torsion}$$

$$\delta_i = \frac{\partial U}{\partial F_i} = \int \frac{1}{EI}\left(M\frac{\partial M}{\partial F_i}\right)dx \qquad \text{bending}$$

Table 4–2

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

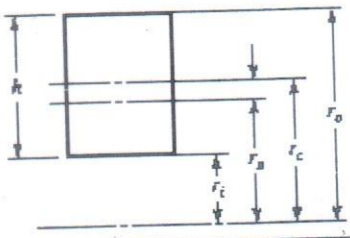
Column End Conditions	End-Condition Constant C		
	Theoretical Value	Conservative Value	Recommended Value*
Fixed-free	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
Rounded-rounded	1	1	1
Fixed-rounded	2	1	1.2
Fixed-fixed	4	1	1.2

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

$$\frac{S_{yc}}{2} = \frac{\pi^2 E}{S_r^2}$$

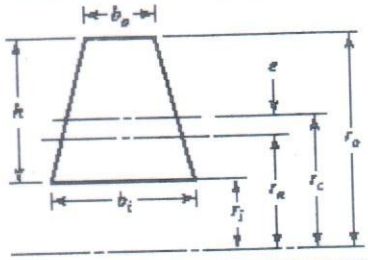
$$(S_r)_D = \pi\sqrt{\frac{2E}{S_{yc}}}$$

$$\frac{P_{cr}}{A} = S_{yc} - \frac{1}{E}\left(\frac{S_{yc}S_r}{2\pi}\right)^2$$



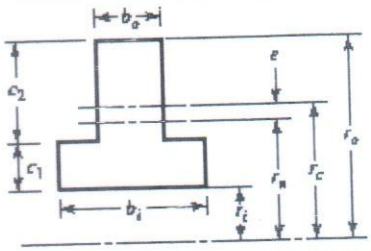
$$r_c = r_i + \frac{h}{2}$$

$$r_n = \frac{h}{\ln(r_o/r_i)}$$



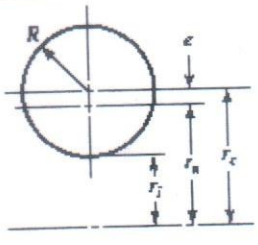
$$r_c = r_i + \frac{h}{3}\frac{b_i + 2b_o}{b_i + b_o}$$

$$r_n = \frac{A}{b_o - b_i + [(b_i r_o - b_o r_i)/h]\ln(r_o/r_i)}$$



$$r_c = r_i + \frac{b_i c_1^2 + 2b_o c_1 c_2 + b_o c_2^2}{2(b_o c_2 + b_i c_1)}$$

$$r_n = \frac{b_i c_1 + b_o c_2}{b_i \ln[(r_i + c_1)/r_i] + b_o \ln[r_o/(r_i + c_1)]}$$



$$r_c = r_i + R$$

$$r_n = \frac{R^2}{2(r_c - \sqrt{r_c^2 - R^2})}$$

Table A–15

Charts of Theoretical Stress-Concentration Factors K_t^* *(Continued)*

Figure A–15–4

Notched rectangular bar in bending. $\sigma_0 = Mc/I$, where $c = d/2$, $I = td^3/12$, and t is the thickness.

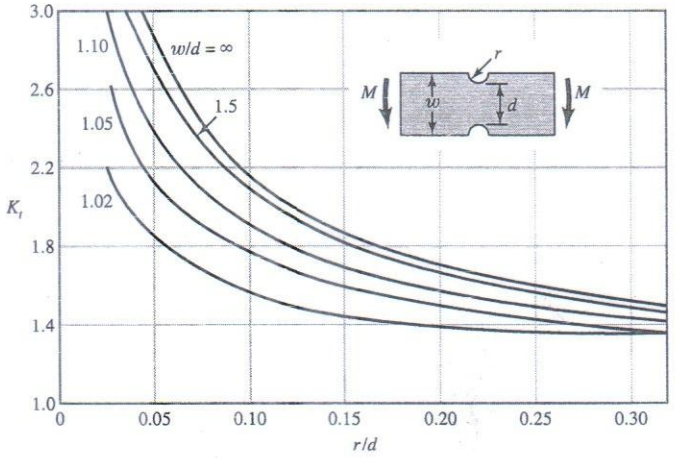


Figure A–15–5

Rectangular filleted bar in tension or simple compression. $\sigma_0 = F/A$, where $A = dt$ and t is the thickness.

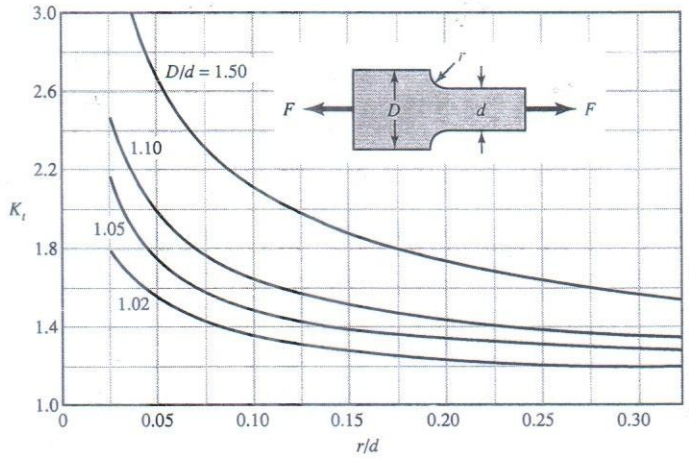
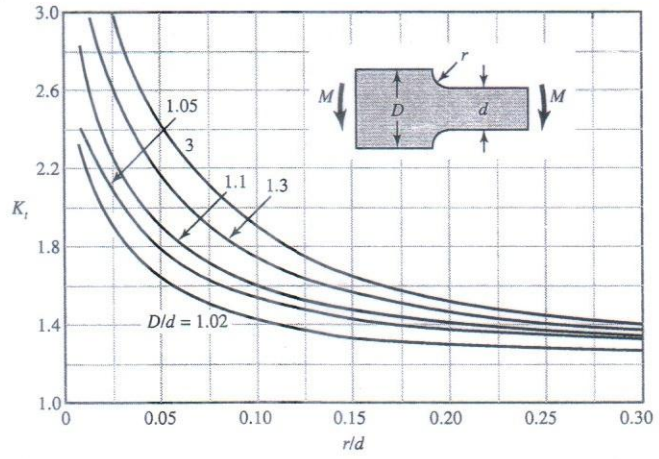


Figure A–15–6

Rectangular filleted bar in bending. $\sigma_0 = Mc/I$, where $c = d/2$, $I = td^3/12$, t is the thickness.



(Continued)

*Factors from R. E. Peterson, "Design Factors for Stress Concentration," Machine Design, vol. 23, no. 2, February 1951, p. 169; no. 3, March 1951, p. 161, no. 5, May 1951, p. 159; no. 6, June 1951, p. 173; no. 7, July 1951, p. 155. Reprinted with permission from Machine Design, a Penton Media Inc. publication.

Table A–15

Charts of Theoretical Stress-Concentration Factors K_t^* (*Continued*)

Figure A–15–7

Round shaft with shoulder fillet in tension. $\sigma_0 = F/A$, where $A = \pi d^2/4$.

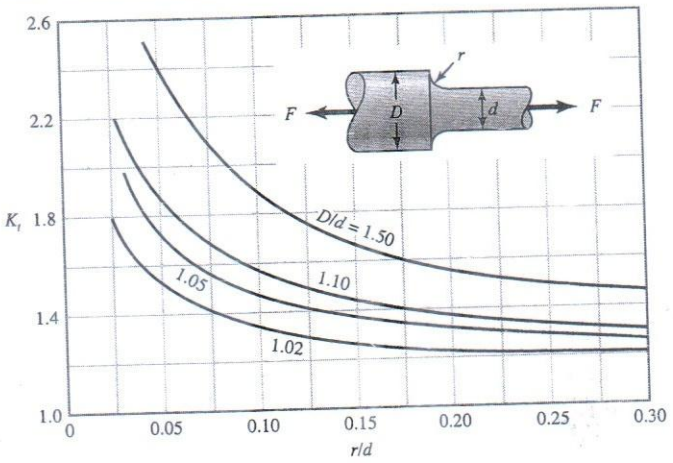


Figure A–15–8

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

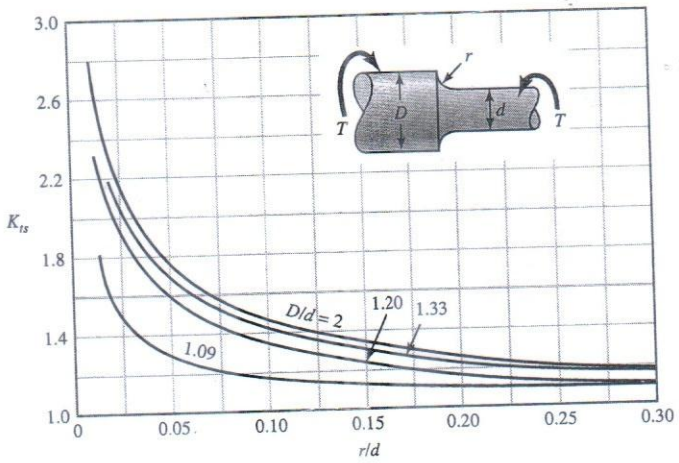


Figure A–15–9

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

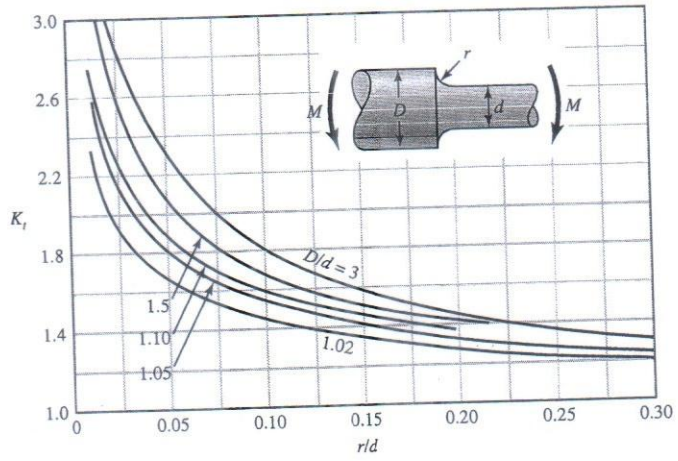
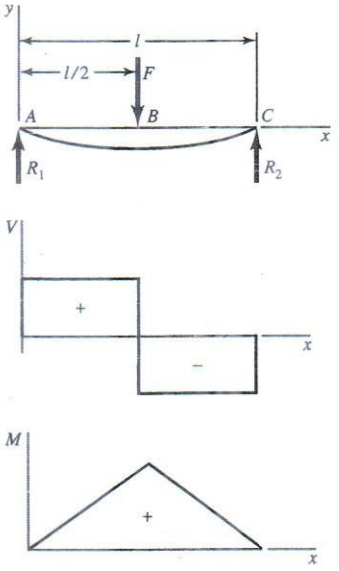


Table A–9

Shear, Moment, and Deflection of Beams (*Note:* Force and moment reactions are positive in the directions shown; equations for shear force V and bending moment M follow the sign conventions given in Sec. 3–2.) (*Continued*)

5 Simple supports—center load



$$R_1 = R_2 = \frac{F}{2}$$

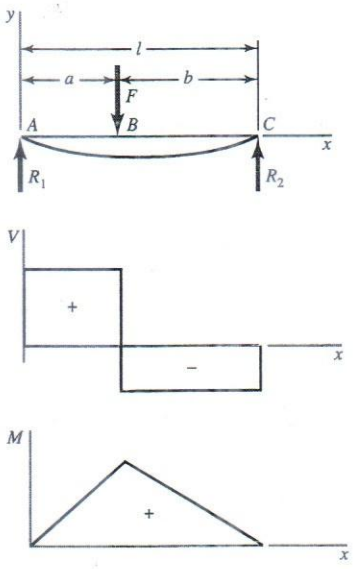
$$V_{AB} = R_1 \qquad V_{BC} = -R_2$$

$$M_{AB} = \frac{Fx}{2} \qquad M_{BC} = \frac{F}{2}(l - x)$$

$$y_{AB} = \frac{Fx}{48EI}(4x^2 - 3l^2)$$

$$y_{\max} = -\frac{Fl^3}{48EI}$$

6 Simple supports—intermediate load



$$R_1 = \frac{Fb}{l} \qquad R_2 = \frac{Fa}{l}$$

$$V_{AB} = R_1 \qquad V_{BC} = -R_2$$

$$M_{AB} = \frac{Fbx}{l} \qquad M_{BC} = \frac{Fa}{l}(l - x)$$

$$y_{AB} = \frac{Fbx}{6EIl}(x^2 + b^2 - l^2)$$

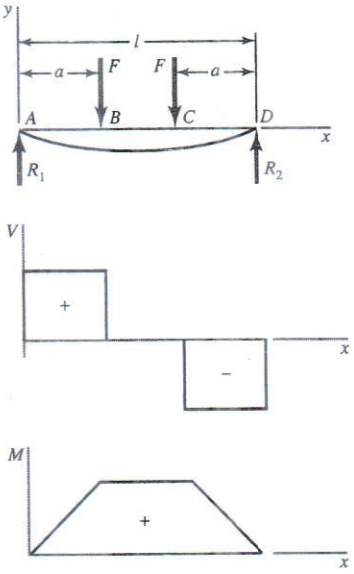
$$y_{BC} = \frac{Fa(l - x)}{6EIl}(x^2 + a^2 - 2lx)$$

(*Continued*)

Table A–9

Shear, Moment, and Deflection of Beams (*Note:* Force and moment reactions are positive in the directions shown; equations for shear force V and bending moment M follow the sign conventions given in Sec. 3–2.) (*Continued*)

9 Simple supports—twin loads



$$R_1 = R_2 = F \qquad V_{AB} = F \qquad V_{BC} = 0$$

$$V_{CD} = -F$$

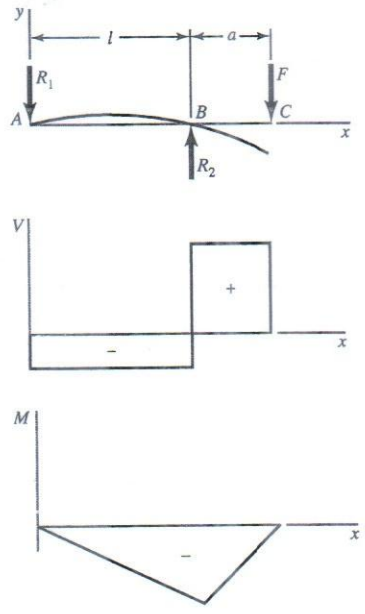
$$M_{AB} = Fx \qquad M_{BC} = Fa \qquad M_{CD} = F(l - x)$$

$$y_{AB} = \frac{Fx}{6EI}(x^2 + 3a^2 - 3la)$$

$$y_{BC} = \frac{Fa}{6EI}(3x^2 + a^2 - 3lx)$$

$$y_{\max} = \frac{Fa}{24EI}(4a^2 - 3l^2)$$

10 Simple supports—overhanging load



$$R_1 = \frac{Fa}{l} \qquad R_2 = \frac{F}{l}(l + a)$$

$$V_{AB} = -\frac{Fa}{l} \qquad V_{BC} = F$$

$$M_{AB} = -\frac{Fax}{l} \qquad M_{BC} = F(x - l - a)$$

$$y_{AB} = \frac{Fax}{6EIl}(l^2 - x^2)$$

$$y_{BC} = \frac{F(x - l)}{6EI}[(x - l)^2 - a(3x - l)]$$

$$y_c = -\frac{Fa^2}{3EI}(l + a)$$

(*Continued*)

Table A–24

Mechanical Properties of Three Non-Steel Metals

(a) Typical Properties of Gray Cast Iron

[The American Society for Testing and Materials (ASTM) numbering system for gray cast iron is such that the numbers correspond to the *minimum tensile strength* in kpsi. Thus an ASTM No. 20 cast iron has a minimum tensile strength of 20 kpsi. Note particularly that the tabulations are *typical* of several heats.]

ASTM Number	Tensile Strength S_{ut}, kpsi	Compressive Strength S_{uct}, kpsi	Shear Modulus of Rupture S_{su}, kpsi	Modulus of Elasticity, Mpsi		Endurance Limit* S_e', kpsi	Brinell Hardness H_B	Fatigue Stress-Concentration Factor K_f
				Tension†	Torsion			
20	22	83	26	9.6–14	3.9–5.6	10	156	1.00
25	26	97	32	11.5–14.8	4.6–6.0	11.5	174	1.05
30	31	109	40	13–16.4	5.2–6.6	14	201	1.10
35	36.5	124	48.5	14.5–17.2	5.8–6.9	16	212	1.15
40	42.5	140	57	16–20	6.4–7.8	18.5	235	1.25
50	52.5	164	73	18.8–22.8	7.2–8.0	21.5	262	1.35
60	62.5	187.5	88.5	20.4–23.5	7.8–8.5	24.5	302	1.50

*Polished or machined specimens.

†The modulus of elasticity of cast iron in compression corresponds closely to the upper value in the range given for tension and is a more constant value than that for tension.

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

Maximum Shear Theory

p. 234
$$\tau_{max} = \frac{\sigma_1 - \sigma_3}{2} = \frac{S_y}{2n} \tag{5-3}$$

Distortion-Energy Theory

Von Mises stress, p. 237

$$\sigma' = \left[\frac{(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2}{2}\right]^{1/2} \tag{5-12}$$

p. 237
$$\sigma' = \frac{1}{\sqrt{2}}[(\sigma_x - \sigma_y)^2 + (\sigma_y - \sigma_z)^2 + (\sigma_z - \sigma_x)^2 + 6(\tau_{xy}^2 + \tau_{yz}^2 + \tau_{zx}^2)]^{1/2} \tag{5-14}$$

Plane stress, p. 237

$$\sigma' = (\sigma_A^2 - \sigma_A\sigma_B + \sigma_B^2)^{1/2} \tag{5-13}$$

p. 237
$$\sigma' = (\sigma_x^2 - \sigma_x\sigma_y + \sigma_y^2 + 3\tau_{xy}^2)^{1/2} \tag{5-15}$$

Yield design equation, p. 238

$$\sigma' = \frac{S_y}{n} \tag{5-19}$$

Shear yield strength, p. 239

$$S_{sy} = 0.577\, S_y \tag{5-21}$$

Coulomb-Mohr Theory

p. 243
$$\frac{\sigma_1}{S_t} - \frac{\sigma_3}{S_c} = \frac{1}{n} \tag{5-26}$$

where S_t is tensile yield (ductile) or ultimate tensile (brittle), and S_t is compressive yield (ductile) or ultimate compressive (brittle) strengths.

Modified Mohr (Plane Stress)

$$\sigma_A = \frac{S_{ut}}{n} \qquad \sigma_A \geq \sigma_B \geq 0 \tag{5-32a}$$

$$\sigma_A \geq 0 \geq \sigma_B \quad \text{and} \quad \left|\frac{\sigma_B}{\sigma_A}\right| \leq 1$$

p. 250
$$\frac{(S_{uc} - S_{ut})\sigma_A}{S_{uc}S_{ut}} - \frac{\sigma_B}{S_{uc}} = \frac{1}{n} \qquad \sigma_A \geq 0 \geq \sigma_B \quad \text{and} \quad \left|\frac{\sigma_B}{\sigma_A}\right| > 1 \tag{5-32b}$$

$$\sigma_B = -\frac{S_{uc}}{n} \qquad 0 \geq \sigma_A \geq \sigma_B \tag{5-32c}$$

In this way everyone who is party to the communication knows what a design factor (or factor of safety) of 2 means and adjusts, if necessary, the judgmental perspective.

6–17 Road Maps and Important Design Equations for the Stress-Life Method

As stated in Sec. 6–15, there are three categories of fatigue problems. The important procedures and equations for deterministic stress-life problems are presented here.

Completely Reversing Simple Loading

1 Determine S'_e either from test data or

p. 290
$$S'_e = \begin{cases} 0.5S_{ut} & S_{ut} \le 200 \text{ kpsi } (1400 \text{ MPa}) \\ 100 \text{ kpsi} & S_{ut} > 200 \text{ kpsi} \\ 700 \text{ MPa} & S_{ut} > 1400 \text{ MPa} \end{cases} \tag{6–8}$$

2 Modify S'_e to determine S_e.

p. 295
$$S_e = k_a k_b k_c k_d k_e k_f S'_e \tag{6–18}$$

$$k_a = aS_{ut}^b \tag{6–19}$$

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

Rotating shaft. For bending or torsion,

p. 296
$$k_b = \begin{cases} (d/0.3)^{-0.107} = 0.879d^{-0.107} & 0.11 \le d \le 2 \text{ in} \\ 0.91d^{-0.157} & 2 < d \le 10 \text{ in} \\ (d/7.62)^{-0.107} = 1.24d^{-0.107} & 2.79 \le d \le 51 \text{ mm} \\ 1.51d^{-0.157} & 51 < 254 \text{ mm} \end{cases} \tag{6–20}$$

For axial,

$$k_b = 1 \tag{6–21}$$

Nonrotating member. Use Table 6–3, p. 298, for d_e and substitute into Eq. (6–20) for d.

p. 298
$$k_c = \begin{cases} 1 & \text{bending} \\ 0.85 & \text{axial} \\ 0.59 & \text{torsion} \end{cases} \tag{6–26}$$

p. 299 Use Table 6–4 for k_d, or

$$k_d = 0.975 + 0.432(10^{-3})T_F - 0.115(10^{-5})T_F^2 + 0.104(10^{-8})T_F^3 - 0.595(10^{-12})T_F^4 \tag{6–27}$$

pp. 300–301, k_e

Table 6–5

Reliability Factor k_e Corresponding to 8 Percent Standard Deviation of the Endurance Limit

Reliability, %	Transformation Variate z_a	Reliability Factor k_e
50	0	1.000
90	1.288	0.897
95	1.645	0.868
99	2.326	0.814
99.9	3.091	0.753
99.99	3.719	0.702
99.999	4.265	0.659
99.9999	4.753	0.620

pp. 301–302, k_f

3 Determine fatigue stress-concentration factor, K_f or K_{fs}. First, find K_t or K_{ts} from Table A–15.

p. 303 $$K_f = 1 + q(K_t - 1) \quad \text{or} \quad K_{fs} = 1 + q(K_{ts} - 1) \tag{6–32}$$

Obtain q from either Fig. 6–20 or 6–21, pp. 303–304.

Alternatively,

p. 304 $$K_f = 1 + \frac{K_t - 1}{1 + \sqrt{a/r}} \tag{6–33}$$

For $\sqrt{a}$ in units of $\sqrt{\text{in}}$, and S_{ut} in kpsi

Bending or axial: $$\sqrt{a} = 0.246 - 3.08(10^{-3})S_{ut} + 1.51(10^{-5})S_{ut}^2 - 2.67(10^{-8})S_{ut}^3 \tag{6–35a}$$

Torsion: $$\sqrt{a} = 0.190 - 2.51(10^{-3})S_{ut} + 1.35(10^{-5})S_{ut}^2 - 2.67(10^{-8})S_{ut}^3 \tag{6–35b}$$

4 Apply K_f or K_{fs} by *either* dividing S_e by it *or* multiplying it with the purely reversing stress, *not* both.

5 Determine fatigue life constants a and b. If $S_{ut} \geq 70$ kpsi, determine f from Fig. 6–18, p. 293. If $S_{ut} < 70$ kpsi, let $f = 0.9$.

p. 293 $$a = (fS_{ut})^2/S_e \tag{6–14}$$

$$b = -[\log (fS_{ut}/S_e)]/3 \tag{6–15}$$

6 Determine fatigue strength S_f at N cycles, or, N cycles to failure at a reversing stress σ_{rev}

(*Note*: this only applies to purely reversing stresses where $\sigma_m = 0$).

p. 293 $$S_f = aN^b \tag{6–13}$$

$$N = (\sigma_{\text{rev}}/a)^{1/b} \tag{6–16}$$

Fluctuating Simple Loading

For S_e, K_f or K_{fs}, see previous subsection.

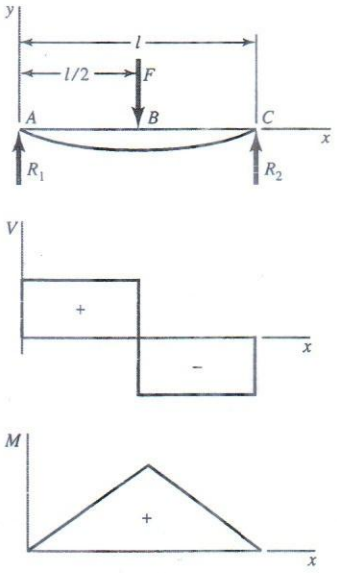
1 Calculate σ_m and σ_a. Apply K_f to both stresses.

p. 309 $$\sigma_m = (\sigma_{\max} + \sigma_{\min})/2 \qquad \sigma_a = |\sigma_{\max} - \sigma_{\min}|/2 \tag{6–36}$$

Table A–9

Shear, Moment, and Deflection of Beams (*Note:* Force and moment reactions are positive in the directions shown; equations for shear force V and bending moment M follow the sign conventions given in Sec. 3–2.) (*Continued*)

5 Simple supports—center load



$$R_1 = R_2 = \frac{F}{2}$$

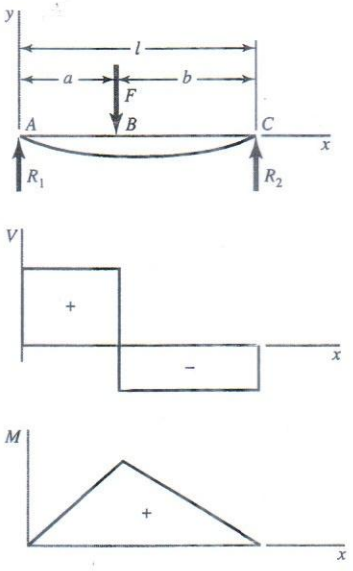
$$V_{AB} = R_1 \qquad V_{BC} = -R_2$$

$$M_{AB} = \frac{Fx}{2} \qquad M_{BC} = \frac{F}{2}(l - x)$$

$$y_{AB} = \frac{Fx}{48EI}(4x^2 - 3l^2)$$

$$y_{\max} = -\frac{Fl^3}{48EI}$$

6 Simple supports—intermediate load



$$R_1 = \frac{Fb}{l} \qquad R_2 = \frac{Fa}{l}$$

$$V_{AB} = R_1 \qquad V_{BC} = -R_2$$

$$M_{AB} = \frac{Fbx}{l} \qquad M_{BC} = \frac{Fa}{l}(l - x)$$

$$y_{AB} = \frac{Fbx}{6EIl}(x^2 + b^2 - l^2)$$

$$y_{BC} = \frac{Fa(l - x)}{6EIl}(x^2 + a^2 - 2lx)$$

(*Continued*)

Table A–15

Charts of Theoretical Stress-Concentration Factors K_t^* (*Continued*)

Figure A–15–7

Round shaft with shoulder fillet in tension. $\sigma_0 = F/A$, where $A = \pi d^2/4$.

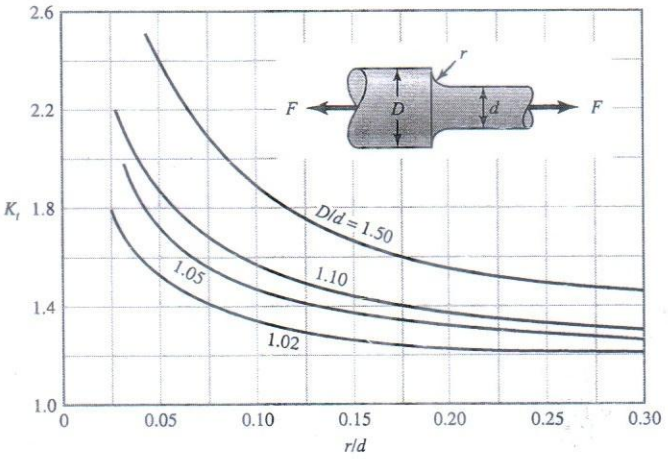


Figure A–15–8

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

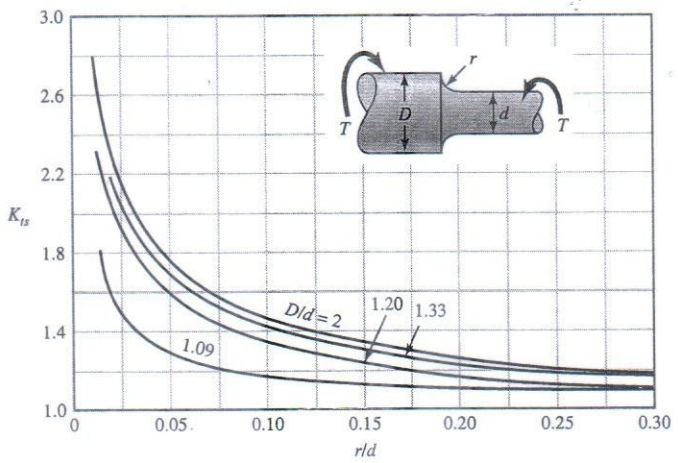
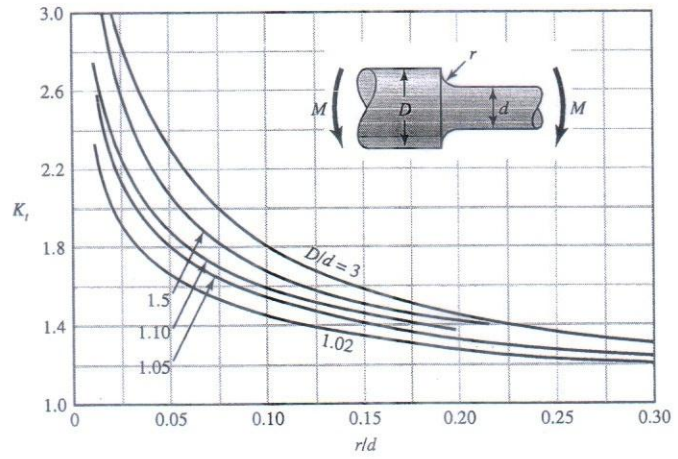


Figure A–15–9

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



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

04 November 2019 (Monday)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Semester Final Examination
Course Code: **MCE 4805/ MCE 4893**
Course Title: **Power Plant Engineering**

Summer Semester : A.Y. 2018-2019
Time : **3 Hours**
Full Marks : **150**

There are 08 (eight) Questions. Answer any 06 (six) of them.
Do not write on the Question Paper. Figures in the Margin indicate the Full Marks.
Assume reasonable data if necessary.

1 a) Explain pulverized coal combustion techniques with its advantages and drawbacks. (10)

b) Discuss elaborately the factors that affect pulverizer-grinding performance along with its processing capacity. (15)

2 a) Explain how a fluidized bed (FBC) boiler works with necessary sketches showing its transformation from fixed bed. (09)

b) Briefly explain the steps for designing a fluidized bed boiler. (07)

c) With the help of a neat sketch, describe the working principle of a typical CFBC boiler. (09)

3 a) Discuss the change in pressure and velocity in impulse turbines and reaction turbines with necessary sketches. (12)

b) Explain in detail the different operating regimes used in steam turbines. (13)

4 a) With a simple schematic diagram, discuss the working principle of combined cycle gas turbine operation. (08)

b) Develop an equation for the intermediate pressure for minimum compressor work in gas turbines. (10)

c) Briefly explain regeneration in gas turbine with neat sketches. (07)

5 a) With the help of a flow diagram, briefly describe fuel gas system of gas turbine power plants. (10)

b) A simple air-standard gas turbine plant is operating on a real Brayton cycle with the maximum and the minimum temperatures at 1050 K and 298 K, respectively. The isentropic efficiency of the compressor is 80% and turbine is 90%. (15)

Determine: (i) the pressure ratio, (ii) inlet gas pressure to turbine (iii) the net-work output (iv) the cycle efficiency and (v) energy lost in the exhaust gas of this gas turbine. (Assume the specific heat of the air at constant pressure is 1.005 kJ/kg.K and γ is 1.4.)

6 a) Discuss different important steps for designing a diesel power plant. (10)

b) Explain the working principle of a supercharger and fuel oil system of diesel power plants. (10)

c) Draw a neat sketch and label all components of a Heat Recovery Steam Generator (HRSG) (05)

7 a) Briefly discuss how thermal energy can be obtained from nuclear reactions. (05)

b) Explain different parts of a nuclear reactor with necessary sketches. (15)

c) Briefly discuss the coolant cycles used in the nuclear reactors. (05)

8 a) With the help of a schematic diagram, discuss Pressurized Water Reactor (PWR) power plants. (10)

b) Discuss the different types of hydroelectric power plants according to operative mode. (15)

~***~

BSc. Engg. (M) 8th Sem. 25 October 2019

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

SEMESTER FINAL EXAMINATION — SUMMER SEMESTER: 2018-2019

Course No: MCE-4811 — TIME : 3HRS

Course Name: Fluid Mechanics II — FULL MARKS: 150

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

---

1. a) Explain the characteristic aspects of Fanno and Rayleigh lines on T-s diagram. (10)
   b) Air enters a converging–diverging nozzle, shown in Fig. 1, at 1.0 MPa and 800 K with negligible velocity. The flow is steady, one-dimensional, and isentropic with k= 1.4. For an exit Mach number of Ma = 2 and a throat area of 20 cm^2, determine (a) the throat conditions, (b) the exit plane conditions, including the exit area, and (c) the mass flow rate through the nozzle. (15)

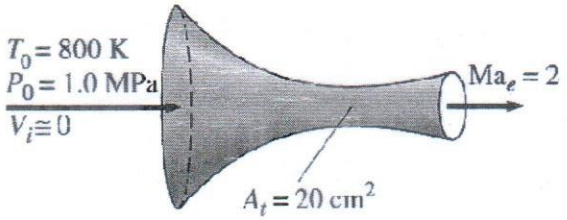


Figure: 1

2. a) Find expression for temperature and pressure at the upstream and downstream of the normal shock. (15)
   b) Derive an expression for area relation with Mach number for a flow through a converging – diverging nozzle. State all the assumptions. (10)

3. a) Derive an expression for velocity distribution of a turbulent flow in a rough pipe. (15)
   b) Consider a turbulent flow in a rough pipe of diameter 300 mm. At a point 25 mm from the pipe wall, the shear velocity is 0.125 m/s and the velocity of flow is 2 m/s. Find velocity gradient of the flow and average height of roughness. (10)

4. a) Derive an expression for power absorbed to overcome friction by Collar bearing. State the assumptions. (15)
   b) In a journal bearing of diameter 60.16 mm and length 100 mm, a shaft of diameter 60 mm rotates concentrically at a speed of 700 RPM. The annular space between the shaft and bearing is filled with an oil of having viscosity of 0.1 Ns/m^2. Find the shear force using Newton's law of viscosity and power absorbed in overcoming the friction. (10)

5. a) Elaborate the significance of Dimensional analysis and Similitude in fluid mechanics applications. (10)
   b) A 1:5-scale model of a torpedo is tested in a wind tunnel to determine the drag force. The prototype operates in water, has 533 mm diameter, and is 6.7 m long. The desired operating speed of the prototype is 28 m/s. To avoid compressibility effects in the wind tunnel, the maximum speed is limited to 110 m/s. However, the pressure in the wind tunnel can be varied while holding the temperature constant at 20^0C. At what minimum pressure should the wind tunnel be operated to achieve a dynamically similar test? At dynamically similar test conditions, the drag force on the model is measured as 618 N. Evaluate the drag force expected on the full-scale torpedo. (15)

6. a) The pressure drop (ΔP), for steady, incompressible viscous flow through a straight horizontal pipe depends on the pipe length (l), the average velocity ($\bar{V}$), the fluid viscosity μ, the pipe diameter (D), the fluid density (ρ), and the average "roughness" height (ϵ). Determine a set of dimensionless groups that can be used to correlate data. (15)
   b) One-dimensional unsteady flow in a thin liquid layer is described by the equation (10)

$$\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} = -g\frac{\partial h}{\partial x}$$

Use a length scale, L, and a velocity scale, V_0, to nondimensionalize this equation. Obtain the dimensionless groups that characterize this flow.

7. a) Explain with necessary diagrams the Boundary layer thickness, Displacement thickness, Momentum thickness and Energy thickness for a flow over flat plate. (10)
   b) Derive an expression for Displacement thickness for a flow over flat plate. (15)

8. a) What do you mean by hydro-dynamically rough and smooth boundary? Explain. (10)
   b) Find Displacement thickness, Momentum thickness and Energy thickness for the velocity distribution in the boundary layer is given by, (15)

$$\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - \left(\frac{y}{\delta}\right)^2$$

Notations have their usual meaning.

TABLE A–33

One-dimensional normal-shock functions for an ideal gas with $k = 1.4$

Ma_1	Ma_2	P_2/P_1	ρ_2/ρ_1	T_2/T_1	P_{02}/P_{01}	P_{02}/P_1
1.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.8929
1.1	0.9118	1.2450	1.1691	1.0649	0.9989	2.1328
1.2	0.8422	1.5133	1.3416	1.1280	0.9928	2.4075
1.3	0.7860	1.8050	1.5157	1.1909	0.9794	2.7136
1.4	0.7397	2.1200	1.6897	1.2547	0.9582	3.0492
1.5	0.7011	2.4583	1.8621	1.3202	0.9298	3.4133
1.6	0.6684	2.8200	2.0317	1.3880	0.8952	3.8050
1.7	0.6405	3.2050	2.1977	1.4583	0.8557	4.2238
1.8	0.6165	3.6133	2.3592	1.5316	0.8127	4.6695
1.9	0.5956	4.0450	2.5157	1.6079	0.7674	5.1418
2.0	0.5774	4.5000	2.6667	1.6875	0.7209	5.6404
2.1	0.5613	4.9783	2.8119	1.7705	0.6742	6.1654
2.2	0.5471	5.4800	2.9512	1.8569	0.6281	6.7165
2.3	0.5344	6.0050	3.0845	1.9468	0.5833	7.2937
2.4	0.5231	6.5533	3.2119	2.0403	0.5401	7.8969
2.5	0.5130	7.1250	3.3333	2.1375	0.4990	8.5261
2.6	0.5039	7.7200	3.4490	2.2383	0.4601	9.1813
2.7	0.4956	8.3383	3.5590	2.3429	0.4236	9.8624
2.8	0.4882	8.9800	3.6636	2.4512	0.3895	10.5694
2.9	0.4814	9.6450	3.7629	2.5632	0.3577	11.3022
3.0	0.4752	10.3333	3.8571	2.6790	0.3283	12.0610
4.0	0.4350	18.5000	4.5714	4.0469	0.1388	21.0681
5.0	0.4152	29.000	5.0000	5.8000	0.0617	32.6335
∞	0.3780	∞	6.0000	∞	0	∞

TABLE A–32

One-dimensional isentropic compressible-flow functions for an ideal gas with $k = 1.4$

Ma	Ma*	A/A^*	P/P_0	ρ/ρ_0	T/T_0
0	0	∞	1.0000	1.0000	1.0000
0.1	0.1094	5.8218	0.9930	0.9950	0.9980
0.2	0.2182	2.9635	0.9725	0.9803	0.9921
0.3	0.3257	2.0351	0.9395	0.9564	0.9823
0.4	0.4313	1.5901	0.8956	0.9243	0.9690
0.5	0.5345	1.3398	0.8430	0.8852	0.9524
0.6	0.6348	1.1882	0.7840	0.8405	0.9328
0.7	0.7318	1.0944	0.7209	0.7916	0.9107
0.8	0.8251	1.0382	0.6560	0.7400	0.8865
0.9	0.9146	1.0089	0.5913	0.6870	0.8606
1.0	1.0000	1.0000	0.5283	0.6339	0.8333
1.2	1.1583	1.0304	0.4124	0.5311	0.7764
1.4	1.2999	1.1149	0.3142	0.4374	0.7184
1.6	1.4254	1.2502	0.2353	0.3557	0.6614
1.8	1.5360	1.4390	0.1740	0.2868	0.6068
2.0	1.6330	1.6875	0.1278	0.2300	0.5556
2.2	1.7179	2.0050	0.0935	0.1841	0.5081
2.4	1.7922	2.4031	0.0684	0.1472	0.4647
2.6	1.8571	2.8960	0.0501	0.1179	0.4252
2.8	1.9140	3.5001	0.0368	0.0946	0.3894
3.0	1.9640	4.2346	0.0272	0.0760	0.3571
5.0	2.2361	25.000	0.0019	0.0113	0.1667
∞	2.2495	∞	0	0	0

$$Ma^* = Ma\sqrt{\frac{k+1}{2 + (k-1)Ma^2}}$$

$$\frac{A}{A^*} = \frac{1}{Ma}\left(\frac{2}{k+1}\right)\left(1 + \frac{k-1}{2}Ma^2\right)^{0.5(k+1)/(k-1)}$$

$$\frac{P}{P_0} = \left(1 + \frac{k-1}{2}Ma^2\right)^{-k/(k-1)}$$

$$\frac{\rho}{\rho_0} = \left(1 + \frac{k-1}{2}Ma^2\right)^{-1/(k-1)}$$

$$\frac{T}{T_0} = \left(1 + \frac{k-1}{2}Ma^2\right)^{-1}$$

$$T_{01} = T_{02}$$

$$Ma_2 = \sqrt{\frac{(k-1)Ma_1^2 + 2}{2kMa_1^2 - k + 1}}$$

$$\frac{P_2}{P_1} = \frac{1 + kMa_1^2}{1 + kMa_2^2} = \frac{2kMa_1^2 - k + 1}{k+1}$$

$$\frac{\rho_2}{\rho_1} = \frac{P_2/P_1}{T_2/T_1} = \frac{(k+1)Ma_1^2}{2 + (k-1)Ma_1^2} = \frac{V_1}{V_2}$$

$$\frac{T_2}{T_1} = \frac{2 + Ma_1^2(k-1)}{2 + Ma_2^2(k-1)}$$

$$\frac{P_{02}}{P_{01}} = \frac{Ma_1}{Ma_2}\left[\frac{1 + Ma_2^2(k-1)/2}{1 + Ma_1^2(k-1)/2}\right]^{(k+1)/[2(k-1)]}$$

$$\frac{P_{02}}{P_1} = \frac{(1 + kMa_1^2)[1 + Ma_2^2(k-1)/2]^{k/(k-1)}}{1 + kMa_2^2}$$

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

Semester Final Examination — Summer Semester, A.Y. 2018-2019
Course No. Hum 4817 — Time:3hours
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.

1	a)	In your own words give a comprehensive meaning of *human resources management* in an organization. Why is human called resources?	5
	b)	Suppose you have been placed as the human resources manager in an engineering organization producing automotive parts like chassis, drives and others for a competitive market. Relating to automotive industry, enumerate (list) the functions you would carry out for your human resources and give reasons behind them.	10
	c)	There are a variety of training being conducted to develop human capability for better and comprehensive outputs. Name at least three prominent types of training and highlight their features.	10
2	a)	"Employee performance appraisal is to enhance employee potential". Elaborate the statement with sufficient key points.	7
	b)	Explain the common limitations of performance appraisal being seen in many organizations.	8
	c)	Explain performance appraisal methodology using the relevant diagram/s. Diagram/s alone is not sufficient.	10
3	a)	How is *thinking map* relevant to an engineering design process? Give a reasonable thinking map in designing a piston of an engine.	6
	b)	Human being is the best of creations for they are awarded *virtue of consciousness or ability to think*. Explain the statement considering the significance of brainstorming in solving any major problem.	6
	c)	Suppose IUT management is aiming to eliminate all sorts of non-value adding activities on the campus (ragging, imposing financial pressure upon students for irrelevant programs, etc.). Enumerate such problems and suggest how brainstorming methodology can be applied among the students to resolve these issues. Set the moral standards for IUT students.	13
4	a)	What have you understood by just-in-time (JIT)concept in manufacturing? Write adequately.	5
	b)	Give a comprehensive meaning of the term 'wastes' from the Qur'an and Japanese management system. Explain with examples, why any waste is unwanted in manufacturing and service organizations.	10
	c)	How can you implement lean manufacturing in a production plant? Use the necessary diagram/s on its steps or system.	10
5	a)	What are *technology management* and *technology strategy*?	5
	b)	Write the key points on *managerial standpoints* of technology management.	5
	c)	State the eight stages for *reviewing technological innovation*.	5
	d)	Can your country become a technology leader in next 10 years? Give at least five reasons in favor of your answer.	5
	e)	Illustrate *technology life cycle* through figures and statements.	5

6 a) "Total productive maintenance (TPM) is both a philosophy and a program". How is it a philosophy and then a program? 5

b) State the names of big losses in process or equipment maintenance and categories them into three main items to measure the process or equipment effectiveness into a single term. Answer comprehensively. 6

c) In a production plant, a process uses equipment and the following data has been collected. 14

Shift length	8 hours
Breaks	Twice 15 minutes each and once 30 minutes
Downtime	47 minutes
Ideal cycle time	1.0 sec
Total count	19,272 units
Reject count	423 units

Determine the following,

i. Planned production time
ii. Run time
iii. Good count
iv. Availability
v. Performance
vi. Quality, and
vii. Overall process effectiveness.

7 a) Relate and differentiate Maslow's needs to Herzberg's hygiene and motivation factors. Please do not just draw a figure on them but put critical remarks. 7

b) Explain the difference between horizontal and vertical job enlargement. 6

c) A manufacturing company has conducted a time study for 10 cycles of a job. The job has 5 elements and the total elemental times (minutes) for each element and performance rating factors are as follow. Show all calculations to 12

Element	$\sum t$ (min)	Rating factor
1	3.61	1.05
2	4.84	0.90
3	2.93	1.00
4	4.91	1.10
5	1.78	0.95

i. Compute the standard time using an allowance factor of 18 percent.
ii. Determine the sample size, n, for this time study at 98% confidence level (z = 2.33), where average time is computed from the time study is within 4 percent of the actual average cycle time. The sample standard deviation is given to be 0.23. Hint $n = \left(\frac{zs}{p\bar{t}}\right)^2$

8 a) What does a learning curve (LC) specifically measure? How? 6

b) Discuss some of the uses and limitations of LCs. 6

c) A military contractor is manufacturing an electronic component for a weapons system. It is estimated from the production of a prototype unit that 176 hours of direct labor will be required to produce the first unit. The industrial standard LC for this type of component is 90%. However, there are unskilled workers and rate busters. Assume reasonable learning rates for them the contractor wants to know the labor hours that will be required for 144^{th} unit produced. Compute it for him for all three types of workers. If each is standard hour costs Tk300, what would be differences in per hour payments. Show all calculations. 13

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B.Sc. Engg. (ME)/8th Sem. 29 October 2019

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

Semester Final Examination — Summer Semester, A. Y. 2018-19
Course No MCE 4887 — Time: 3 Hours
Course Title: Fundamentals of Road Vehicle Dynamics — Full Marks: 150

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

Figures in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper. Symbols have their usual meanings. Some formulas are provided at the end of the question.

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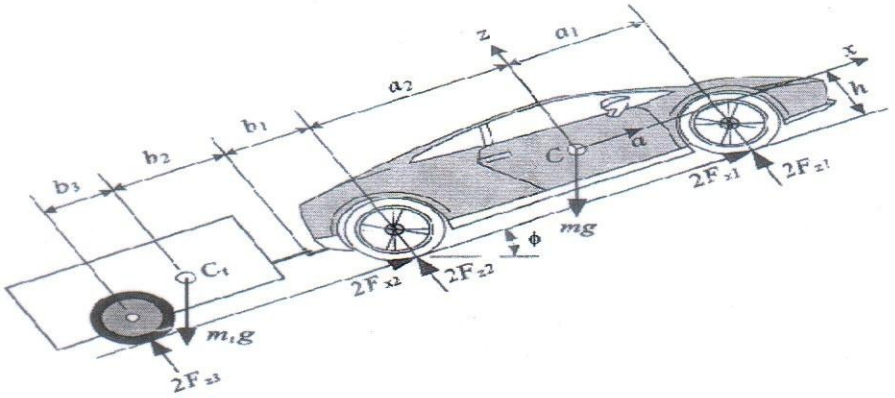
1. a) Describe basic components of a tire with appropriate figures. [13]
   b) Write down three main functions of tires. In a tire sidewall the following is written: P 215/60 R 15 95 H Write down the information that you may obtain from it. Also find out the section height of the tire [12]

2. a) Derive dynamic axle loads mathematical expressions for a car with a trailer attached while is moving up making an angle with acceleration. [13]
   b) A four wheel drive car is parked on a level road. Find the force at the hinge when the following information is provided. [12]
   For the car, m = 2500 kg , wheelbase, l= 2800 mm, a_1=a_2
   For the trailer, m_t = 600 kg, b_1= 850 mm, b_2= 1300 mm, b_3=150 mm, hinge is located at the same height of the centre of gravity of the trailer thus



3. a) What do you understand by road loads? Briefly describe rolling resistance phenomena by mentioning hysteresis effect. [12]
   b) A car weighing 72000 lb rolls along at a speed of 67 mph. The air temperature is 55^0F and barometric pressure is 26 inches of Mercury. It is 8 feet wide by 13.5 feet high, and has an aerodynamic drag coefficient of 0.65. The car uses bias-ply tires and assume road surface coefficient is 1 Calculate the aerodynamic drag, the rolling resistance and the road load horsepower at these conditions. [13]

4. a) Derive dynamic axle loads mathematical expressions for a car moving up on a dip in an inclined road. [13]

b) A car is moving on a plane surface with acceleration. Its mass is 1500 kg, wheelbase is 2600 mm, distance from the road surface to the centre of gravity is 700 mm, and coefficient of friction with the road surface is 0.8. Assume distance from the centre of gravity to the front axle and rear axle is equal. Now determine the maximum acceleration if the car is *rear-wheel drive*. [12]

5. a) Derive the equations for stopping distance and time to stop under constant deceleration condition. [13]
   b) If a light truck weighing 3000 lb performing full stop from 60 mph on a level surface with a brake application that develops a steady brake force of 1800 lb, determine the deceleration, stopping distance, time to stop, energy dissipated and brake horsepower at initial application as well as averaged over the stop. Neglect aerodynamic and rolling resistance forces. [12]

6. a) Write short notes on the following topics: [9]
   i) Characteristic speed ii) Caster angle iii) Ackerman Angle
   b) What do you understand by rollover? Derive the appropriate mathematical expression for threshold Lateral Acceleration for rollover [16]

7. What do you understand by Anti-squat and anti-pitch? Derive the appropriate mathematical expression for anti-pitch and anti squat geometry by first using two control arms and then by equivalent trailing arm. [25]

8. a) Describe steering geometry error that causes toe change and roll steer with example [10]
   b) Describe any two types of suspensions with their advantages and disadvantages. [15]

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Formulas:

$$\rho = 0.00236 \left(\frac{P_r}{29.92}\right)\left(\frac{519}{460 + T_r}\right)$$

$f_r = (0.0041 + 0.000041\ V)\ C_h$ **Radial tires**

$f_r = (0.0066 + 0.000046\ V)\ C_h$ **Bias-ply tires**

M Sc. Eng./PhD(M) 01 November, 2019 (Morning)

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

Semester Final Examination — Summer Semester, A.Y. 2019
Course Code: Math 6103 — Time : 03 hours
Course Title: Advanced Mathematics — Full Marks: 150

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) Show that the function $z = \ln(x^2 + y^2) + 2\tan^{-1}(y/x)$ satisfies the Laplace's equation.

   b) Let L(x, y) denote the local linear approximation to $f(x, y) = \sqrt{x^2 + y^2}$ at the point (3, 4). Compare the error in approximating $f(3.04, 3.98)$.

2. a) Find the directional derivative of $f(x, y, z) = x^2y - yz^3 + z$ at the point (1,–2, 0) in the direction of the vector $\mathbf{a} = 2\mathbf{i} + \mathbf{j} - 2\mathbf{k}$. What is the magnitude and direction of maximum rate of change of $f(x, y, z)$ at this point.

   b) Use a double integral to find the volume of the solid bounded by the cylinder $x^2 + y^2 = 4$ and the planes $y + z = 4$ and $z = 0$.

3. Discuss the basic idea of eigenvalues and eigenvectors. Find the eigenvalues and corresponding eigenvectors of the matrix $A = \begin{bmatrix} 5 & 3 & -1 \\ 3 & 5 & -1 \\ -3 & -3 & 3 \end{bmatrix}$; Is the matrix diagonalizable? If so, find a nonsingular matrix P that diagonalizes A, and write down the diagonal matrix D so that $P^{-1}AP = D$.

4. a) Find the volume of the solid enclosed between the circular paraboloid $z = x^2 + y^2$, the right circular cylinder $x^2 + y^2 = 4$, and the xy-plane.

   b) Find parametric equations of the tangent line to the circular helix $x = \cos t$, $y = \sin t$, $z = t$ at the point where $t = \pi$.

5. a) For which values of 'a' will the system

$$x + 2y - 3z = 4$$
$$3x - y + 5z = 2$$
$$4x + y + (a^2 - 14)z = a+2$$

have no solutions? Unique solution? Infinitely many solutions?

b) Augmented matrix for a system of linear equations has been reduced to canonical form $\begin{bmatrix} 1 & 0 & 0 & 4 & -1 \\ 0 & 1 & 0 & 2 & 6 \\ 0 & 0 & 1 & 3 & 2 \end{bmatrix}$ by row operations. Solve the system.

6. Solve the following boundary value problem by the method of separation of variables.

$$\frac{\partial u}{\partial t} = 2\frac{\partial^2 u}{\partial x^2} \quad ; \; 0 < x < 3 \; , t > 0, \text{ given that } u(0,t) = u(3,t) = 0$$

$$u(x,0) = 5\sin 4\pi x - 3\sin 8\pi x + 2\sin 10\pi x \quad , \quad |u(x, t)| < M .$$

7. A circular plate of unit radius, whose faces are insulated, has half of its boundary kept at constant temperature u_1 and the other half at constant temperature u_2. Find the steady state temperature of the plate.

8. Using Legendre functions find the potential v (i) interior to and (ii) exterior a hollow sphere of unit radius if half of its surface is charged to potential v_0 and the other half to potential zero.

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MSc TE - 4th Sem.

B.Sc.Eng/8th Sem.(MCE) 24 October 2019

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

Semester Final Examination — Summer Semester, A.Y. 2018-2019
Course No. MCE 6231 — Time : 3 hours
Course Title: Technology Management — Full Marks : 150

THIS IS AN OPEN BOOK EXAM.

There are **7** (Seven) Questions. Answer any **5** (Five) of them.
Marks in the Margin indicate the full marks. Answer the questions with sufficient key points and/or arguments wherever necessary.

1	a)	What must be included in writing an abstract for a journal paper on technology management? Give an example.	8
	b)	"Developing countries often buy technology rather developing technology". What do you understand by this statement and technology transfer for these countries?	12
	c)	Construct a bridge between knowledge gathering for technology transfer.	10
2	a)	Contrast between patents, copyrights and trademarks.	9
	b)	What is intellectual property and how do we see ethical-moral orientation towards safeguarding intellectual property rights?	12
	c)	Give a picture how Allah SWT inspires to do research on His Created things for serving the mankind and obeying Him. Explain using the verses from the Qur'an.	9
3	a)	CO_2 emission has become an alarming concern for the environment and ecological balance. Draw a picture on its emission and narrate the breakthrough technologies for its reduction. Use the journal papers published by Elsevier and other reputed publishers. Use figures, tables and whatever other things are relevant.	30
4	a)	Write an essay on legal aspects of technology transfer 1,000 words. Cover all the main aspects.	20
	b)	Write a short note on strategic technology management system.	10
5	a)	Give a clear meaning of the term *technology assessment*.	6
	b)	Describe the main dimensions of technology assessment and issues related therein. Use diagram/s and explain.	12
	c)	Explain with examples - traditional and modern process-based concepts of creativity. How it is related to innovation?	12
6	a)	What are the variables pertaining to innovation? With appropriate diagrams, explain the requirements and procedure of innovation.	12
	b)	How economic processing zones (EPZ) promote technology transfer and sustainable economic growth? Write vividly.	18
7	a)	Discuss the design issues of a case study to implement total productive maintenance.	6
	b)	How can you give justification on implementation of a productive maintenance system for maintaining technology at enterprise level? Write elaborately.	6
	c)	A manufacturing unit has been producing a range of electrical terminal blocks. Working conditions are: 2 shifts a day, 8 hours per shift, and 5 days per week. Planned throughput is 60 units/hr. However, the actual output is 3320 units/week. The actual output falls behind the planned production due to a variety of losses. A list of losses during machining process is given below:	18

a. The circular saw blade which cuts off the materials shatters and has to be replaced. This happens once per week and takes 30 minutes time.

b. Saw pivot arm gets so congested with swarf and oil, it becomes stiff and does not function properly. It is to be dismantled and cleaned. This happens twice per week and takes 45 minutes each time.

c. Cutting fluid is sprayed into the bar feeder causing bar to slip and not get fed properly with two consequences:

   - if part feed occurs then block is cut off too short. This happens three times per day, takes 10 minutes each time to clear and 3 parts are lost every day.
   - if the bar does not feed then the machine stops, has to be cleared and re-set. This happens twice per week and takes 45 minutes altogether.

d. On first drilling head of the main bearings get dry causing the head to slow down and then seize up. This happens once every 6 weeks, the machine operates at half speed for one day prior to breaking down and to repair and replace the head it takes 18 hours.

e. On the 2nd tapping head, the tap breaks and is undetected i.e., parts have to be tapped by hand. This happens once every day, 20 parts have to be reworked, 10 parts are scrapped and it takes 15 minutes to replace the tap.

f. To set up the machine for a new block, machine parts have to be swapped and re-set and the stroke of the drills adjusted. This happens four times per week and takes 2½ hours.

g. Swarf builds up at the rear of the machine and has to be shoveled into a barrow. The operator has to stop the machine whilst doing this. This happens 3 times per day and takes 10 minutes each time.

h. The operator has to wait for the compressed air pressure to build up at the start of each shift. This takes 15 minutes per day.

Questions:

i. Find the total availability losses, total performance losses, and total quality losses for a week.

ii. Determine the overall machine effectiveness. Show the results in an *effctogram*. Are these results satisfactory? Give reason(s).

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M. Sc. Engg. (MCE) 24th October, 2019

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

Semester Final Examination	Winter Semester	: **A.Y. 2018-2019**
Course Code: **MCE 6351**	Time	: **3.0 Hours**
Course Title: **Advanced Heat Transfer and CFD**	Full Marks	: **150**

There are **08 (Eight)** Questions. Answer **06 (Six)** of them in total.
You **MUST** answer **Questions 1, 2, 3**.
Do not write on the question paper. Marks in the Margin indicate the full marks.

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1. What is central differencing scheme? A property Φ is transported by means of convection and diffusion through the one-dimensional domain. The boundary conditions are $\Phi_0 = 1$ at $x = 0$ and $\Phi_L = 0$ at $x = L$. Using five equally spaced cells and the central differencing scheme for convection and diffusion, calculate the distribution of Φ as a function of x for (i) Case 1: u = 0.1 m/s, (ii) Case 2: u = 2.5 m/s, and compare the results with the analytical solution **25**

$$\frac{\emptyset - \emptyset_0}{\emptyset_L - \emptyset_0} = \frac{\exp\left(\frac{\rho u x}{\Gamma}\right) - 1}{\exp\left(\frac{\rho u L}{\Gamma}\right) - 1}$$

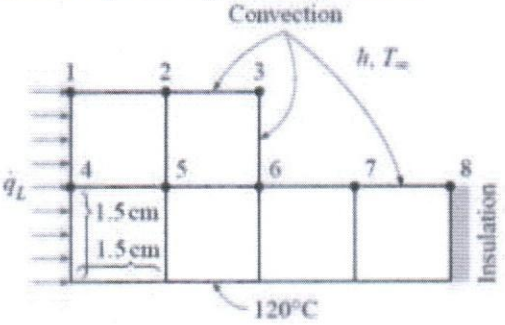
2. Explain the steps by Finite volume method for one dimensional steady state diffusion. Assume the process of cooling of a circular fin by means of convective heat transfer along its length. Convection gives rise to a temperature-dependent heat loss or sink term in the governing equation. Consider a cylindrical fin with uniform cross sectional area A. The base is at a temperature of 100°C (T_B) and the end is insulated. The fin is exposed to an ambient temperature of 20°C. One dimensional heat transfer in this situation is governed by, **25**

$$\frac{d}{dx}\left(kA\frac{dT}{dx}\right) - hP(T - T_\alpha) = 0$$

where h is the convective heat transfer coefficient, P the perimeter, k the thermal conductivity of the material and T_α the ambient temperature. Calculate the temperature distribution along the fin and compare the results with the analytical solution given by

$$\frac{T - T_\alpha}{T_B - T_\alpha} = \frac{\cosh[n(L - x)]}{\cosh(nL)}$$

3. Consider steady two-dimensional heat transfer in an L-shaped solid body whose cross section is given in the figure. The thermal conductivity of the body is k = 45 W/m.°C, and heat is generated in the body at a rate of $\dot{g}$ = 5 x 10^6 W/m^3. The right surface of the body is insulated, and the bottom surface is maintained at a uniform temperature of 120°C. The entire top surface is subjected to convection with ambient air at T_α= 30°C with a heat transfer coefficient of h =55 W/m^2 ·°C, and the left surface is subjected to heat flux at a uniform rate of q_L= 8000 W/m^2. The nodal network of the problem consists of 13 equally spaced nodes with $\Delta x = \Delta y$=1.5 cm. Five of the nodes are at the bottom surface and thus their temperatures are known. (*a*) Obtain the finite difference equations at the remaining eight nodes and (*b*) determine the nodal temperatures by solving those equations. **25**



4. Derive the Navier Stokes equations for a Newtonian fluid for unsteady, three-dimensional fluid flow and heat transfer. **25**

5. Why Large Eddy Simulation (LES) is important? Derive an expression considering the spatial filtering of unsteady Navier-Stokes equations. **25**

6. What are the characteristics of hydrodynamic stability in laminar flow? Derive an expression for Prandtl's mixing length model. **25**

7. Discuss about the method of SIMPLE, SIMPLER, SIMPLEC and PISO algorithms for pressure-velocity coupling in 2D steady flow equations in Cartesian co-ordinates. **25**

8. What are the common boundary conditions in the discretized equations of the finite volume method? Briefly discuss about Symmetry, periodic and potential pitfalls for flow in a CFD solution domain. **25**