

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination

Summer Semester, A.Y. 2017-2018

Course Code: Math 4211

Time : 1½ hours

Course Title: Differential Equations and Special Functions

Full Marks : 100

There are 4 (Four) Questions. Answer any 3 (Three) 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.

1. a) Classify the following equations as linear or non-linear, homogeneous or non-homogeneous, ordinary or partial, and by their order.

$$(i) y' + t^2 y = e^t$$

$$(ii) 2y'' + 3y' - y = te^{-t}$$

$$(iii) y' = y(y+1)(y-1)$$

$$(iv) y''' - 2y' + ty - y^2 = 0$$

- b) Verify by substitution that each given function is a solution to the given differential equation (DE). Throughout these problems, primes denote derivatives with respect to x .

$$x^2 y'' - xy' + 2y = 0, y_1 = x \cos(\ln x), y_2 = x \sin(\ln x)$$

- c) Plot the solution curves and slope field for the DE for the appropriate ranges for variables x and y

$$y' = x^2 - y$$

2. a) Find the explicit particular solution(PS) to the following initial value problem(IVP)

$$\begin{cases} y' = 2xy + 3x^2 ye^{x^3} \\ y(0) = 5 \end{cases}$$

- b) A tank originally contains 100 liters of pure water. Salt water with a concentration of 2 kg/L is pumped into the tank at 3 L/min, and the well-mixed solution is drained at the same rate.

(i) Set up an initial value problem describing the situation. Be sure to explain all of your variables.

(ii) Solve the initial value problem to find the amount of salt in the tank at any time t

(iii) What is the limiting concentration of salt in the tank?

- c) Find the integrating factor of the following DE and then find general solution(GS):

$$5y^4 y' = x^2 y' + 2xy$$

3. a) Determine whether the DE $y' - \frac{x}{x^2+1}y = 2x(x^2+1)$ is exact or not. If not, convert it to an exact DE and solve it.
- b) In a warehouse kept at a constant temperature of 60F, a corpse was found at noon with a temperature of 85F. Ninety minutes later, its temperature dropped to 79F. At the time of death, considering that the person's body temperature was at the normal 99F.
- (i) Set up an initial value problem describing the situation.
- (ii) When did the person die?

4. a) Find the solution to the following IVP

$$\begin{cases} (1+x)y' + y = \sin x \\ y(0) = 1 \end{cases}$$

- b) A body falling vertically under gravity encounters resistance of the atmosphere. If the resistance varies as the velocity,
- (i) show that the equation of motion is given by $\frac{du}{dt} = g - ku$
where u is the velocity, k is a constant and g is the acceleration due to gravity.
- (ii) Show that as t increases, u approaches the value $\frac{g}{k}$.
- (iii) Also, if $u = \frac{dx}{dt}$, where x is the distance fallen by the body from rest in time t , show that

$$x = \frac{gt}{k} - \frac{g}{k^2}(1 - e^{-kt}).$$

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

Mid-Semester Examination

Summer Semester 2017-2018

Course No. Phy 4213

Time: 1.5 HRS.

Course Title: Waves & Oscillations,
 Geometrical Optics and
 Wave Mechanics

Full Marks: 75

There are **FOUR** Questions. Answer any **THREE** Questions
 Marks in the Margin indicate full marks

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

1. (a) Discuss simple harmonic motion (SHM). What are its characteristics? 18
 Establish the differential equation of SHM of a particle and hence solve it to obtain the expression for the displacement of the particle.
- (b) A particle executes SHM expressed by $x = 12 \sin 2\pi (t/10 + 1/8)$. 7
 Find i) amplitude, ii) frequency, iii) epoch, iv) displacement at $t = 1.25$ s, and v) velocity at $t = 2.5$ s.
2. (a) What are Lissajous' figures? Obtain the general expression for the resultant vibration of a particle simultaneously acted upon by two mutually perpendicular SH vibrations, having the same time period but different phases and amplitudes. 18
- (b) Obtain the expressions and draw the corresponding Lissajous' figures when the phase values are i) 0, ii) $\pi/4$, iii) $\pi/2$, and iv) π . 7
3. (a) Distinguish between damped and forced vibrations. A particle executing damped simple harmonic motion is subjected to an external periodic force. Establish the differential equation of motion for this particle. Write down the solution of this equation and explain its significance. 18
- (b) What is resonance? Discuss sharpness of resonance. 7
4. (a) State and explain Doppler's effect in sound? Derive 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) Show that if the source moves away with the velocity of sound from an observer who is at rest, the frequency of vibration is halved. 7

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DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination Summer Semester, A.Y. 2017-2018
 Course Code: **MCE 4241** Time : 1.5 hours
 Course Title: **Computer Programming and Application** Full Marks : 50

There are 4 (four) Questions. Answer any 3 (three) of them.

Figures in the Margin indicate the full marks. The symbols have their usual meaning.

1. a) What are the basic components of a C program? Explain them briefly. 6
 b) Why do we need to use a comment in C? Write down the basic characteristics of single line and multiple line comment. 4
 c) Write a C program that accepts two integers from the user and calculate the sum, product, subtraction of those two integers and it will show the results in the output screen. $6\frac{2}{3}$

2. a) What do you mean by data type and format specifier? Write down all the primary data types along with their format specifiers. 5
 b) What is ASCII code & ASCII character? Write a program which will take any character as input and print that character's ASCII code as an output. 6
 c) What is a variable and how it is declared in C programming? Explain with example. $5\frac{2}{3}$

3. a) Why do you need to use loop in C programming? Explain how nested if else works. 4
 b) Write down the differences between while loop and do.. while loop with example. Write down the syntax for if, if .. else and for loop . $8\frac{2}{3}$
 c) Write the output for the program below **exactly** as it will appear on the console 4

```
#include <stdio.h>
int main()
{
    int number=50, i;
    printf("Factors of %d are:\n ", number);
    for(i=1; i <= number; ++i)
    {
        if (number%i == 0)
        {
            printf("%d,",i);
        }
    }

    return 0;
}
```


- 4. a) What is local variable and global variable in C program? Explain with example. 4²₃
- b) What is user define function? What are the advantages of user define function. 3
- c) Write a C program that will calculate the sum of the natural number (1, 2, 3.....n) using for loop and while loop. 6
- d) Write the output for the program below **exactly** as it will appear on the console. 3

```
#include <stdio.h>
void fun( void);
int main (void)
{
    printf("I was born in \n");
    fun();
    printf( " Boardbazar.");
    return 0;
}
void fun()
{
    printf("Gazipur.");
}
```


B.Sc. Eng. (CEE)/ 2nd Sem.

13 August, 2018 (Afternoon)

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

Mid Semester Examination

Course Code: Math 4253

Course Title: Vector Algebra, Vector Calculus, ODE

Summer Semester, A.Y. 2017-2018

Time : 1½ hours

Full Marks: 75

There are 4 (Four) Questions. Answer any 3 (Three) 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.

1. a) Classify the following equations as linear or non-linear, homogeneous or non-homogeneous, ordinary or partial, and by their order.

$$(i) t^2 \frac{d^2 y}{dt^2} + t \frac{dy}{dt} + 2y = \sin t$$

$$(ii) (1 + y^2) \frac{d^2 y}{dt^2} + t \frac{dy}{dt} + y = e^t$$

$$(iii) \frac{d^2 y}{dt^2} + \sin(t + y) = \sin t$$

$$(iv) u_{xx} + u_{yy} + u_{zz} = 0$$

- b) Verify by substitution that each given function is a solution to the given differential equation (DE). Throughout these problems, primes denote derivatives with respect to x .

$$t^2 y'' + 5t' + 4y = 0, t > 0; y_1(t) = t^{-2}, y_2(t) = t^{-2} \ln t$$

- c) Plot the solution curves and slope field for the DE for the appropriate ranges for variables x and y

$$y' = 1 + 2y$$

2. a) Find the explicit particular solution(PS) to the following initial value problem(IVP)

$$\begin{cases} y' = (1 - 2x)y^2 \\ y(0) = -1/6 \end{cases}$$

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

- c) Find the integrating factor of the following DE and then find general solution(GS):

$$y' - 2y = t^2 e^{2t}$$

3. a) Determine whether the DE $(3xy + y^2) + (x^2 + xy)y' = 0$ is exact or not. If not, convert it to an exact DE and solve it.
- b) In a warehouse kept at a constant temperature of 70F, a corpse was found at noon with a temperature of 87F. Ninety minutes later, its temperature dropped to 80F. At the time of death, considering that the person's body temperature was at the normal 98F.
- (i) Set up an initial value problem describing the situation.
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$$\begin{cases} (1+x)y' + y = \sin x \\ y(0) = 1 \end{cases}$$

- b) A body falling vertically under gravity encounters resistance of the atmosphere. If the resistance varies as the velocity,
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- (ii) Show that as t increases, u approaches the value $\frac{g}{k}$.
- (iii) Also, if $u = \frac{dx}{dt}$, where x is the distance fallen by the body from rest in time t , show that $x = \frac{gt}{k} - \frac{g}{k^2}(1 - e^{-kt})$.

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DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

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

SUMMER SEMESTER: 2017-2018
TIME : 1½ HRS
FULL MARKS : 100

There are **Four** Questions. Answer any **Three** 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) A composite circular member is fabricated from brass and steel shown in Fig.1. It is subjected to axial loads as shown in the figure. If the total deflection of the member is to be zero, what will be the axial load P ? Take $E_{st} = 200$ GPa and $E_{br} = 100$ GPa. (16)

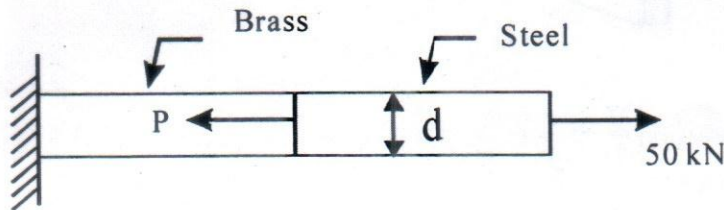


Fig.1

- (b) A uniform rigid block weighing 160 kN is to be supported on three bars as shown in Fig.2. Outside two bars are made of aluminum and the central bar is made of steel. The cross section of the aluminum bar and the steel bar is $20 \times 20 \text{ mm}^2$ and $25 \times 25 \text{ mm}^2$ respectively. There is 4 mm gap between the block and the top of the steel bar. Determine the stresses developed in the bars. Take $E_S = 200$ GPa and $E_A = 80$ GPa. (17.33)

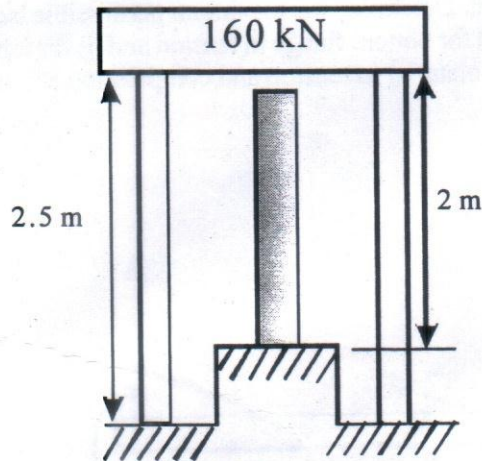


Fig.2

2. An overhanging beam is loaded as shown in Fig. 3. Draw the shear force and bending moment diagram. Find also the point of contraflexure, if any. (33.33)

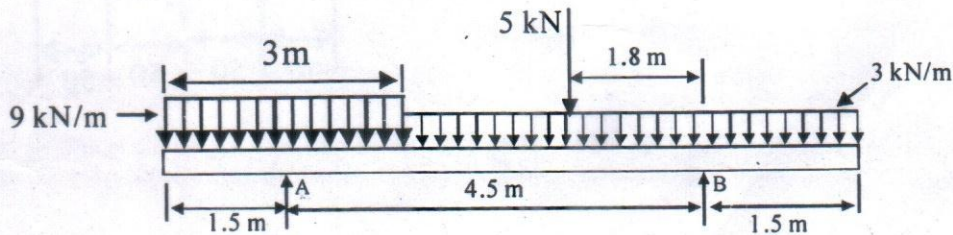


Fig. 3

3. (a) Derive the expression $\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$ for the solid shaft of uniform circular cross-section (13.33) throughout its length where T is the applied external torque, J is the polar moment of inertia, τ is the shear stress, G is the modulus of rigidity, L is the length, θ is the angle of twist and R is the radius.

(b) The stepped steel shaft shown in Fig.4 is subjected to a torque (T) at the free end and a torque ($2T$) in the opposite direction at the junction of the two sections. The diameter and the length of the section AB are 120 mm and 1.2 m respectively. The diameter and length of the section BC are 60 mm and 1.8 m respectively. What is the total angle of twist at the free end, if maximum shear stress in the shaft is limited to 80 MPa? Assume the modulus of rigidity to be 90 GPa. (20)

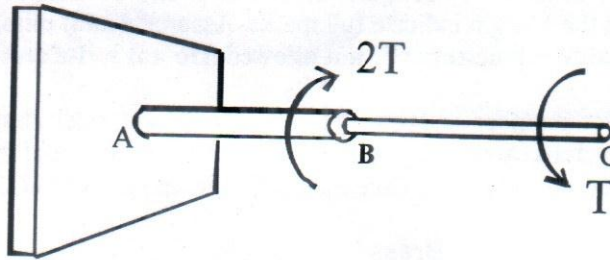


Fig.4

4. (a) Derive the expression $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$ for the elastic bending of a beam. Symbols represent the usual meaning. (15.33)

(b) A conveyor beam has the cross-section shown in Fig.5 and it is subjected to a bending moment. Determine the maximum permissible bending moment which can be applied to the beam i) for bottom flange in tension and ii) for top flange in compression, if the safe stresses for the material in tension and compression are 30 MPa and 150 MPa respectively. (18)

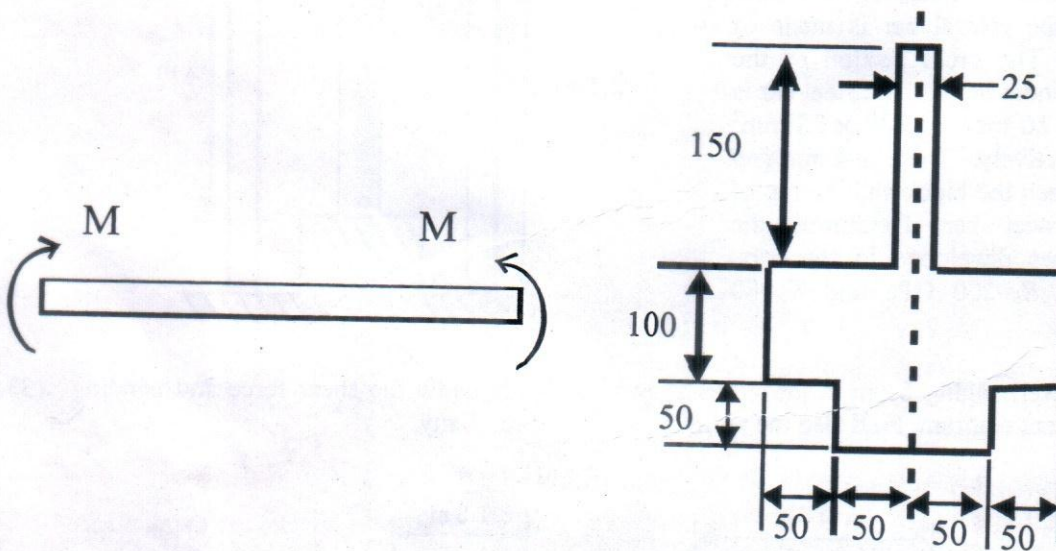


Fig. 5 All dimensions are in mm

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

Mid Semester Examination
Course No.: MCE 4407
Course Title: Instrumentation and Measurements

Summer Semester, A. Y. 2017-2018
Time: 1 Hours 30 Min(s)
Full Marks: 75

There are 4 (Four) questions. Answer any 3 (Three) questions.

All questions carry equal marks/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) Describe how you can reduce systematic errors by the method of calibration and opposing inputs. 12

2. a) Explain what is meant by 13
 - i) Analogue instruments, ii) Digital instruments

Give examples of each and discuss the relative merits and demerits of these two classes of instruments.
- b) Define sensitivity drift and zero drift. What factors can cause sensitivity drift and zero drift in instrument characteristics? 12

3. a) What is piezoelectric transducer? Explain how a piezoelectric transducer can be used as a small vibration shakers. 13
- b) Write down the working principle of a hall effect sensor. Using a hall effect sensor, how do you do the following works. Explain with measurement setup diagrams. 12
 - i) Sensing a head-on movement
 - ii) Sensing a side-by movement
 - iii) Sensing a notch
 - iv) Sensing a metal body

4. a) Resistance thermometers and thermistors are both temperature-measuring devices that convert the measured temperature into a resistance change. What are the main differences between these two types of devices in respect of the materials used in their constructions? 13

An RTD forms one arm of an equal-arm Wheatstone bridge, as shown in Figure 1. The fixed resistances, R_2 and R_3 are equal to 30Ω . The RTD has a resistance of 35Ω at a temperature of 0°C and is used to measure a temperature that is steady in time. A temperature measurement is made by placing the RTD in the measuring environment of 135°C and balancing the bridge by adjusting R_1 . The value of R_1 required to balance the bridge is 37.36Ω . Determine the coefficient of resistance for this RTD.

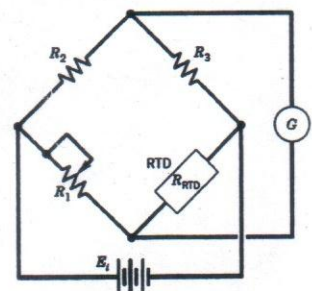


Figure 1

- b) What is a thermocouple? Explain cold junction compensation for thermocouple arrangement. 12

B Sc. Eng./HDME(4th Semester)/B Sc TE(2 Yr/2nd Semester) August 09, 2018 (Morning)

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination

Course Code: Math-4411/Math-4699

Course Title: Linear Algebra

Summer Semester, A.Y. 2017-2018

Time : 1½ hours

Full Marks : 75

There are 4 (Four) Questions. Answer any 3 (Three) of them. All Questions carry equal Marks. Programmable calculators are not allowed. Do not write on this question paper. The Symbols have their usual meanings.

1. a) Solve the following linear system by Gauss-Jordan elimination method:

$$3x_1 + 2x_2 - x_3 = -15$$

$$5x_1 + 3x_2 + 2x_3 = 0$$

$$3x_1 + x_2 + 3x_3 = 11$$

$$6x_1 - 4x_2 + 2x_3 = 30$$

- b) A system represents by linear equations is given below. Find the value of a for the cases:
(i) infinite (ii) no solution (iii) unique solution.

$$x + y + 7z = -7$$

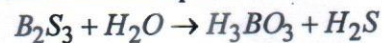
$$2x + 3y + 17z = -16$$

$$x + 2y + (a^2 + 1)z = 3a$$

2. a) Apply elementary row operations to transform the following matrix first into echelon form and then into reduced echelon form:

$$\begin{bmatrix} 0 & 3 & -6 & 6 & 4 & -5 \\ 3 & -7 & 8 & -5 & 8 & 9 \\ 3 & -9 & 12 & -9 & 6 & 15 \end{bmatrix}$$

- b) Boron sulfide reacts violently with water to form boric acid and hydrogen sulfide gas (the smell of rotten eggs). The unbalanced equation is



Balance the above chemical equations using the linear system of equation/vector equation approach.

3. a) If $A = \begin{bmatrix} 3 & -2 & 7 \\ 6 & 5 & 4 \\ 0 & 4 & 9 \end{bmatrix}$ and $B = \begin{bmatrix} 6 & -2 & 4 \\ 0 & 1 & 3 \\ 7 & 7 & 5 \end{bmatrix}$ and $C = \begin{bmatrix} 0 & -2 & 3 \\ 1 & 7 & 4 \\ 3 & 5 & 9 \end{bmatrix}$

Find (i) $r_3(BA)$ (ii) $c_2(AB)$ (iii) $tr(AB) - tr(A)tr(B)$ (iv) $tr(B)A + 3X = BC$

- b) (i) Find the general traffic pattern of the freeway network shown in the Figure Q3b.
(Flow rates are in cars/minute.)
(ii) Describe the general traffic pattern when the road whose flow x_5 is closed.
(iii) When $x_5 = 0$, what is the minimum value of x_4 ?

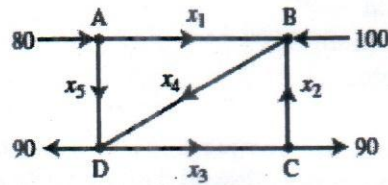


Fig.: Q3b

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

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

- b) Figure Q4b shows a diagram of a simplified industrial robot. The robot consists of two arms that can be rotated independently through angles α and β that can be "telescoped" independently to lengths l_1 and l_2 . For fixed angles $\alpha = 30^\circ$ and $\beta = 45^\circ$, what should the lengths of the arms be in order to position the tip of the working arm at point $(4,5)$ shown in the figure.

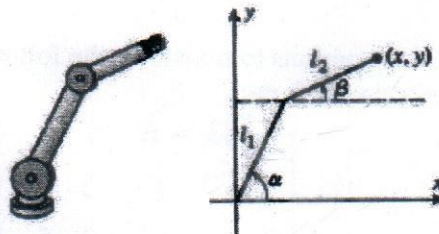


Fig.: Q4b

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DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination
 Course Code: MCE 4413
 Course Title: Heat Transfer: Conduction & Radiation

Summer Semester, A.Y. 2017-2018
 Time : 1½ hours
 Full Marks : 75

There are 4 (Four) Questions. Answer any 3 (Three) of them.
 Do not write on the question paper. Marks in the Margin indicate the full marks.

1. a) Differentiate between Thermodynamics and Heat Transfer. What is Newton's law of cooling? (05)
- b) Derive an expression for Fourier-Biot equation considering the general heat conduction for rectangular coordinates and reduce it to Poisson, Diffusion and Laplace equations. (10)
- c) (i). Find an expression for distribution of temperature and heat flow due to conduction in a circular conical rod in Fig. 1 with diameter 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. (10)

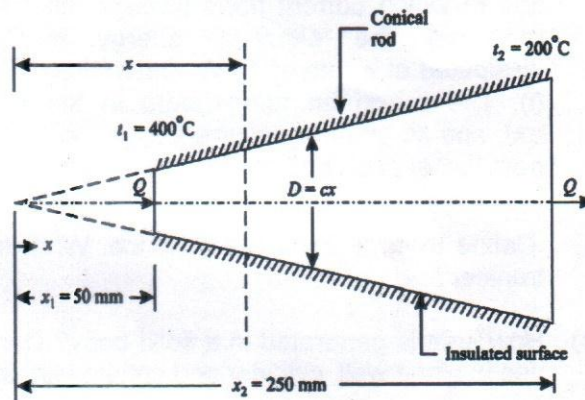


Figure: 1

2. a) What is the purpose of fin? Describe fin effectiveness and fin efficiency. (05)
- b) Derive an expression for one dimensional Heat Conduction Equation in a Long Cylinder for (i) Steady-state, (ii) Transient, no heat generation and (iii) Steady-state, no heat generation conditions. (10)

c) Fig. 2 shows a cylindrical tank of 1.0 m diameter and 5 m total length has hemispherical ends. It contains liquid oxygen which has boiling point and heat of vaporization -180°C and 210°kJ/kg respectively. It is required to insulate the tank so as to reduce the boil-off rate of oxygen in steady state to 14kg/h . Determine the total thermal conductivity of the insulating material if its maximum thickness is limited to 70 mm . Assume room temperature outside the insulation as 25°C .

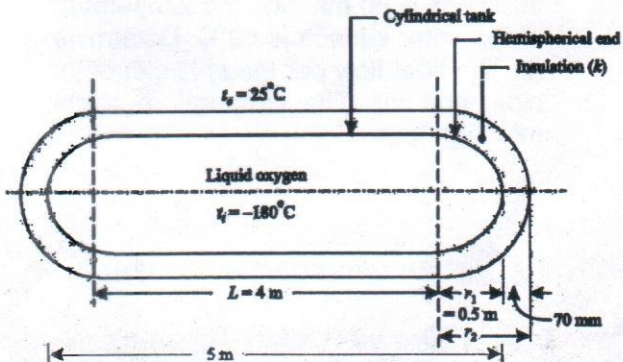


Figure: 2

3. a) Define conductive, convective and radiative resistance in heat transfer. What is thermal resistance network for multi-materials? (05)

b) Consider a sphere of radius r_1 whose surface temperature T_1 is maintained constant. The sphere is now insulated with a material whose thermal conductivity is k and outer radius is r_2 . Heat is lost from the sphere to the surrounding medium at temperature T_a , with a convection heat transfer coefficient h . Prove that the critical radius of insulation for sphere is, $r_{cr} = \frac{2k}{h}$. (10)

c) A steel rod ($k=40 \text{ W/m}^\circ\text{C}$) having 30 mm diameter and 300 mm long separates two large steel plates maintained at 100°C and 75°C as shown in Fig. 3. The space between the plates is filled with insulation which also insulates the circumference of the rod. Voltage difference exists between the two plates due to which current flows through the rod and the electrical energy is dissipated at a rate of 12 W. Determine, (i). The maximum temperature in the rod, and its point of occurrence; (ii) The heat flux at each end. (10)

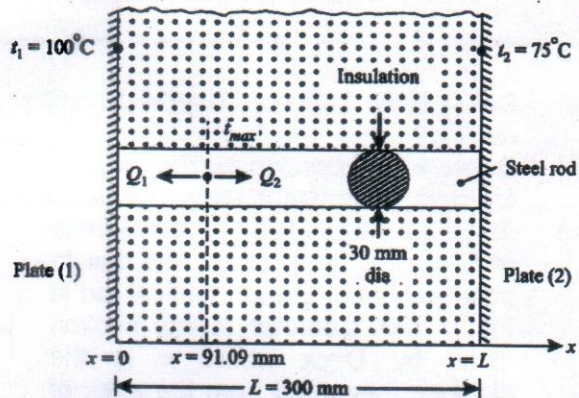


Figure: 3

4. a) Define thermal contact resistance. What are the different boundary conditions in heat transfer? (05)

b) How heat is generated in a solid body? Derive the expression for maximum temperature rise in plane wall, cylinder and sphere with uniform heat generation occurs at its center. (10)

c) As shown in Fig. 4, a steam pipe of 220 mm outer diameter is carrying steam at 280°C . It is insulated with a material having thermal conductivity given in the following equation: $k = 0.06(1 + 0.0018t)$, where k is in $\text{W/m}^\circ\text{C}$ and t is $^\circ\text{C}$. If the insulation thickness is 50 mm and the temperature of the outer surface is 50°C . Determine: (i). The heat flow per meter length of the pipe, and (ii). The temperature at the mid thickness. (10)

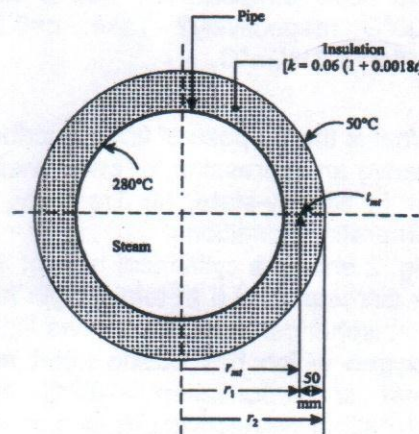


Figure: 4

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

Mid Semester Examination

Course No: HUM 4417

Course Title: Technology, Environment and Society

Summer Semester (2017-2018)

Time : 1hr 30 min.

Full Marks : 75

There are 4 (four) questions. Answer any 3 (three).

Figures in the right margin indicate marks of the questions.

- | | | |
|----|---|----|
| 1. | A) Describe Gaia Hypothesis. | 10 |
| | B) What are the earth system components? Describe them with examples. | 10 |
| | C) What are the major discoveries of the Anthropocene time (era)? | 5 |
| 2. | A) Briefly describe different types of tectonic movement. | 10 |
| | B) How do a mountain and an Ocean form? | 10 |
| | C) Define the term Ecosystem and give examples. | 5 |
| 3. | A) What is ecosystem service? | 5 |
| | B) Classify ecosystem service with examples. | 10 |
| | C) What is the role of the technology for social development? | 10 |
| 4. | A) Draw a pond ecosystem and describe energy flow in an ecosystem. | 10 |
| | B) What is sustainable development? | 5 |
| | C) Describe major impacts of climate change. | 10 |

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
 THE ORGANIZATION OF THE ISLAMIC CONFERENCE (OIC)
DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING
 MID SEMESTER EXAMINATION
 COURSE CODE: MCE 4425
 COURSE TITLE: Metallurgy

SUMMER SEMESTER: 2017-2018
 TIME : 1 ½ HRS
 FULL MARKS: 50

There are **Four** Questions. Answer any **Three** Questions.
 Marks in the Margin indicate full marks.
 Graph paper to be supplied.

1. (a) Explain **any three** of the following terms: (9)
 (i) Ore (ii) Flux (iii) Slag (iv) Smelting (v) Refractory
- (b) Distinguish between **any two** of the following: (7²/₃)
 (i) Hardness and Toughness (ii) Ductility and Malleability (iii) Fatigue and Creep
2. (a) Draw a neat sketch of the iron blast furnace showing its salient parts. (8)
 (b) Mention the raw materials and products of iron blast furnace. (5²/₃)
 (c) "Reduction of iron ore is a step by step process"- Justify. (3)
3. (a) Distinguish between acid Bessemer converter and basic Bessemer converter processes of steel making. (3)
 (b) Draw a neat sketch of a Bessemer converter and describe briefly how steel is produced by the acid Bessemer converter process of steel making. (10)
 (c) Why and how are deoxidation and recarburization carried out at the end of the steel making process? (3²/₃)
4. (a) Distinguish between substitutional solid solution and interstitial solid solution. (4)
 (b) Platinum and gold are completely soluble in both the liquid and solid states. The melting point of platinum is 3225^oF and of gold is 1945^oF. An alloy containing 40 percent gold starts to solidify at 2910^oF by separating crystals of 15 percent gold. An alloy containing 70 percent gold starts to solidify at 2550^oF by separating crystals of 37 percent gold. (12²/₃)
 (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 gold
 (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^oF;
 (4) draw the cooling curve.

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

Mid-Semester Examination

Course Code: MCE 4491

Course Title: **Advanced Manufacturing Process**

Summer Semester A.Y. 2017-2018

Time : 1.5 Hours

Full Marks : 75

There are **4 (Four)** Questions. Answer any **3(Three)** of them.

Assume reasonable data if necessary.

Programmable calculators are not allowed. Don't write on this question paper.

1. a) What is 'Machining'? Write down various chip formation processes. Define *orthogonal* and *oblique machining*. (8)
- b) A 1025 Cold Drawn Carbon Steel (250 HB) of 1.5 diameter bar has to be turned to a 0.9 x 5.00 inch length bar using a *coated carbide single point* cutting tool. Determine (17)
 - a) Depth of cut
 - b) Spindle speed
 - c) Material removal rate
 - d) Cutting time
 - e) Required Horse power
 - f) Cutting Force
2. a) Discuss different angles associated with single point cutting tools. (8)
- b) Discuss the criteria of selecting cutting tools. (17)
3. a) Explain different *tool coating* processes. (7)
- b) Describe various cutting tool materials. (18)
4. a) Discuss different Hole-making processes. (7)
- b) With neat sketches discuss Nomenclature and geometry of conventional twist drill. (18)

Turning, Single Point and Box Tools

Material	Hardness Bhn	Condition	Depth of Cut* in mm	High Speed Steel Tool			Carbide Tool						
				Speed fpm m/min	Feed ipr mm/r	Tool Material AIS1 ISO	Uncoated		Coated				
							Speed		Feed ipr mm/r	Tool Material Grade C ISO	Speed fpm m/min	Feed ipr mm/r	Tool Material Grade C ISO
							Brazed fpm m/min	Index-able fpm m/min					
1. FREE MACHINING CARBON STEELS, WROUGHT (cont.) Medium Carbon Landed (cont.) (materials listed on preceding page)	225 to 275	Hot Rolled, Normalized, Annealed,	.040	160	.008	M2, M3	500	610	.007	C-7	925	.007	CC-7
			.150	125	.015	M2, M3	390	480	.020	C-6	600	.015	CC-6
		Cold Drawn or Quenched and Tempered	.300	100	.020	M2, M3	310	375	.030	C-6	500	.020	CC-6
			.625	80	.030	M2, M3	240	290	.040	C-6	—	—	—
			1	49	.20	S4, S5	150	185	.18	P10	280	.18	CP10
			4	38	.40	S4, S5	120	145	.50	P20	185	.40	CP20
	8	30	.50	S4, S5	95	115	.75	P30	150	.50	CP30		
	16	24	.75	S4, S5	73	88	1.0	P40	—	—	—		
	275 to 325	Hot Rolled, Normalized, Annealed,	.040	135	.007	T15, M42 ¹	460	545	.007	C-7	825	.007	CC-7
			.150	105	.015	T15, M42 ¹	350	425	.020	C-6	525	.015	CC-6
		Quenched and Tempered	.300	85	.020	T15, M42 ¹	275	380	.030	C-6	425	.020	CC-6
			.625	—	—	—	—	—	—	—	—	—	—
			1	41	.18	S9, S11 ¹	140	165	.18	P10	250	.18	CP10
			4	32	.40	S9, S11 ¹	105	130	.50	P20	160	.40	CP20
	8	26	.50	S9, S11 ¹	84	100	.75	P30	130	.50	CP30		
	16	—	—	—	—	—	—	—	—	—	—		
325 to 375	Quenched and Tempered	.040	100	.007	T15, M42 ¹	390	480	.007	C-7	725	.007	CC-7	
		.150	80	.015	T15, M42 ¹	300	375	.020	C-6	475	.015	CC-6	
	Quenched and Tempered	.300	65	.020	T15, M42 ¹	230	290	.030	C-6	375	.020	CC-6	
		.625	—	—	—	—	—	—	—	—	—	—	
		1	30	.18	S9, S11 ¹	120	145	.18	P10	220	.18	CP10	
		4	24	.40	S9, S11 ¹	90	115	.50	P20	145	.40	CP20	
8	20	.50	S9, S11 ¹	70	88	.75	P30	115	.50	CP30			
16	—	—	—	—	—	—	—	—	—	—			
375 to 425	Quenched and Tempered	.040	70	.007	T15, M42 ¹	325	400	.007	C-7	600	.007	CC-7	
		.150	55	.015	T15, M42 ¹	250	310	.020	C-6	400	.015	CC-6	
	Quenched and Tempered	.300	45	.020	T15, M42 ¹	200	240	.030	C-6	325	.020	CC-6	
		.625	—	—	—	—	—	—	—	—	—	—	
		1	21	.18	S9, S11 ¹	100	120	.18	P10	185	.18	CP10	
		4	17	.40	S9, S11 ¹	76	95	.50	P20	120	.40	CP20	
8	14	.50	S9, S11 ¹	60	73	.75	P30	100	.50	CP30			
16	—	—	—	—	—	—	—	—	—	—			
2. CARBON STEELS, WROUGHT Low Carbon 1005 1010 1020 1006 1012 1023 1008 1015 1025 1009 1017	85 to 125	Hot Rolled, Normalized, Annealed or Cold Drawn	.040	185	.007	M2, M3	535	700	.007	C-7	1050	.007	CC-7
			.150	145	.015	M2, M3	435	540	.020	C-6	700	.015	CC-6
		Normalizing, Annealed or Cold Drawn	.300	115	.020	M2, M3	340	420	.030	C-6	550	.020	CC-6
			.625	90	.030	M2, M3	265	330	.040	C-6	—	—	—
			1	56	.18	S4, S5	165	215	.18	P10	320	.18	CP10
			4	44	.40	S4, S5	135	165	.50	P20	215	.40	CP20
	8	35	.50	S4, S5	105	130	.75	P30	170	.50	CP30		
	16	27	.75	S4, S5	81	100	1.0	P40	—	—	—		
	125 to 175	Hot Rolled, Normalized, Annealed or Cold Drawn	.040	150	.007	M2, M3	485	640	.007	C-7	950	.007	CC-7
			.150	125	.015	M2, M3	410	500	.020	C-6	625	.015	CC-6
		Normalizing, Annealed or Cold Drawn	.300	100	.020	M2, M3	320	390	.030	C-6	500	.020	CC-6
			.625	80	.030	M2, M3	245	305	.040	C-6	—	—	—
			1	46	.18	S4, S5	150	195	.18	P10	290	.18	CP10
			4	38	.40	S4, S5	125	150	.50	P20	190	.40	CP20
	8	30	.50	S4, S5	100	120	.75	P30	150	.50	CP30		
	16	24	.75	S4, S5	75	95	1.0	P40	—	—	—		
175 to 225	Hot Rolled, Normalized, Annealed or Cold Drawn	.040	145	.007	M2, M3	460	570	.007	C-7	850	.007	CC-7	
		.150	115	.015	M2, M3	385	450	.020	C-6	550	.015	CC-6	
	Normalizing, Annealed or Cold Drawn	.300	95	.020	M2, M3	300	350	.030	C-6	450	.020	CC-6	
		.625	75	.030	M2, M3	235	265	.040	C-6	—	—	—	
		1	44	.18	S4, S5	140	175	.18	P10	260	.18	CP10	
		4	35	.40	S4, S5	115	135	.50	P20	170	.40	CP20	
8	29	.50	S4, S5	90	105	.75	P30	135	.50	CP30			
16	23	.75	S4, S5	72	81	1.0	P40	—	—	—			
225 to 275	Annealed or Cold Drawn	.040	125	.007	M2, M3	410	510	.007	C-7	750	.007	CC-7	
		.150	95	.015	M2, M3	360	400	.020	C-6	500	.015	CC-6	
	Normalizing, Annealed or Cold Drawn	.300	75	.020	M2, M3	285	315	.030	C-6	400	.020	CC-6	
		.625	60	.030	M2, M3	220	240	.040	C-6	—	—	—	
		1	38	.18	S4, S5	125	155	.18	P10	230	.18	CP10	
		4	29	.40	S4, S5	110	120	.50	P20	150	.40	CP20	
8	23	.50	S4, S5	87	95	.75	P30	120	.50	CP30			
16	18	.75	S4, S5	67	73	1.0	P40	—	—	—			

See section 15.1 for Tool Geometry.

See section 16 for Cutting Fluid Recommendations.

* Caution: Check Horsepower requirements on heavier depths of cut.

¹ Any premium HSS (T15, M33, M41-M47) or (S9, S10, S11, S12).

FIGURE 20-4 Examples of a table for selection of speed and feed for turning. (Source: Metcut's Machinability Data Handbook)

TABLE 20-3 Values for Unit Power and Specific Energy (Cutting Stiffness)

Material		Unit Power (hp-min. in. ³) HP _s	Specific Energy (in.-lb/in. ³) K _s or U	Hardness Brinell HB
Nonalloy carbon steel	C 0.15%	.58	268,000	125
	C 0.35%	.58	302,400	150
	C 0.60%	.75	324,800	200
Alloy steel	Annealed	.50	302,400	180
	Hardened and tempered	0.83	358,400	275
	Hardened and tempered	0.87	392,000	300
	Hardened and tempered	1.0	425,000	350
High-alloy steel	Annealed	0.83	369,000	200
	Hardened	1.2	560,000	325
Stainless steel, annealed	Martensitic/ferritic	0.75	324,800	200
Steel castings	Nonalloy	0.62	257,000	180
	Low-alloy	0.67	302,000	200
	High-alloy	0.80	336,000	225
Stainless steel, annealed	Austenitic	0.73	369,600	180
Heat-resistant alloys	Annealed	0.78	—	200
	Aged—Iron based	—	—	280
	Annealed—Nickel or cobalt	1.10	—	250
	Aged	1.20	—	350
Hard steel	Hardened steel	1.4	638,400	55HR _c
	Manganese steel 12%	1.0	515,200	250
Malleable iron	Ferritic	0.42	156,800	130
	Pearlitic	—	257,600	230
Cast iron, low tensile		0.62	156,800	180
Cast iron, high tensile		0.80	212,800	260
Nodular SG iron	Ferritic	0.55	156,800	160
	Pearlitic	0.76	257,600	250
Chilled cast iron		—	492,800	400
Aluminum alloys	Non-heat-treatable	.25	67,200	60
	Heat-treatable	.33	100,800	100
Aluminum alloys (cast)	Non-heat-treatable	.25	112,000	75
	Heat-treatable	.33	123,200	90
Bronze-brass alloys	Lead alloys, Pb>1%	.25	100,800	110
	Brass, cartridge brass	1.8–2.0	112,000	90
	Bronze and lead-free copper	0.33–0.83	—	—
	Includes Electrolytic copper	0.90	246,400	100
Zinc alloy	Diecast	0.25	—	—
Titanium		.034	250,275	—

Values assume normal feed ranges and sharp tools. Multiply values by 1.25 for a dull tool.

Calculation of unit power (HP_s)

$$HP = F_c V / 33000$$

$$HP_s = HP / MRR \text{ Where}$$

$$MRR = 12Vtw \text{ for tube turning}$$

$$HP_s = F_c V / 12Vtw \times 33000 = F_c / tw \times 396000$$

Calculation of specific energy (U)

$$U = F_c V / Vtw = F_c / tw \text{ for tube turning}$$

This type of estimate of the major force F_c is useful in analysis of deflection and vibration problems in machining and in the proper design of workholding devices, because these devices must be able to resist movement and deflection of the part during the process.

In general, increasing the speed, the feed, or the depth of cut will increase the power requirement. Doubling the speed doubles the horsepower directly. Doubling the feed or the depth of cut doubles the cutting force, F_c . In general, increasing the speed

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

Mid Semester Examination

Summer Semester: A.Y. 2017-2018

Course Code: MCE 4493

Time : $1\frac{1}{2}$ Hours

Course Title : Automotive Maintenance Engineering

Full Marks : 75

There are 4 (Four) Questions. Answer any 3 (Three) Questions.

Figures in the right margin indicate full marks. Don't write on this question paper.

1. a) In a micrometer, the thimble rotates over the sleeve on a screw that has 40 threads per inch. Every revolution of the thimble moves the spindle 0.025 in. The thimble is graduated into 25 equally spaced lines. From figure 01, find the reading. 10



Figure 01: Micrometer

- b) Why signs are posted around machineries in auto shop? What does OSHA stand for? Write down any ten safety rules in auto shop. 15
2. a) Describe the following measuring instruments in brief : 15
- i. Dial indicator
 - ii. Piston ring expander
 - iii. Torque Wrenches
 - iv. Inside and outside calipers
 - v. Feeler gauge
- b) Briefly describe the steps for performing Basic Tune-Ups. 10
3. a) Explain the flushing of Engine Cooling System with necessary diagrams. 10
- b) Explain the following tests in engine cooling system- 15
- i. Cooling system pressure test
 - ii. Combustion leak test
 - iii. Thermostat test
4. a) Describe how to perform the antifreeze servicing. 06
- b) Explain the basic four lubricating system problems. 12
- c) Describe how to replace the filter elements of the two known filters in lubricating system. 07

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ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination
Course Code: MCE 4609/4693
Course Title: Machine Design I

Summer Semester, A.Y. 2017-2018
Time : 1.5 hours
Full Marks : 50

There are 4 (four) Questions. Answer any 3 (three) of them.

Figures in the Margin indicate the full marks. The symbols have their usual meaning.

1. A countershaft carrying two V-belt pulleys is shown in the Figure 1. 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. 16²/₃
- Determine the tensions in the belt on pulley B, assuming the shaft is running at a constant speed.
 - Find the magnitudes of the bearing reaction forces, assuming the bearings act as simple supports.
 - Draw shear-force and bending-moment diagrams for the shaft. If needed, make one set for the horizontal plane and another set for the vertical plane.
 - At the point of maximum bending moment, determine the bending stress and the torsional shear stress.

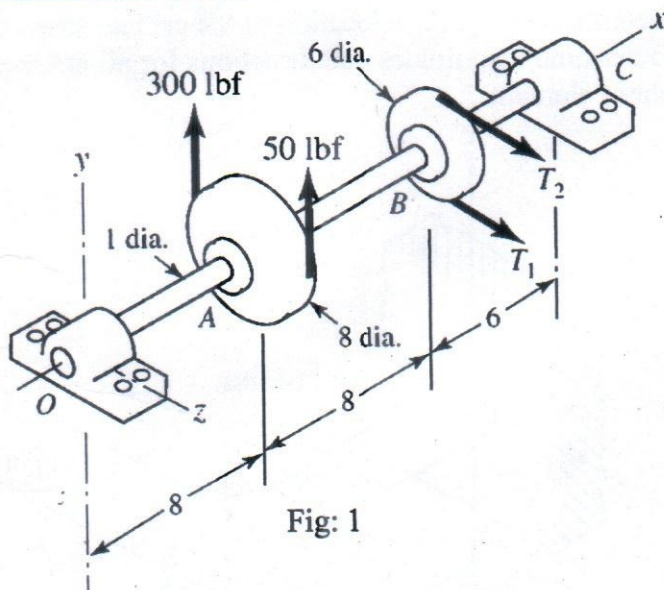


Fig: 1

- A pressure cylinder has an outer diameter $d_o = 6$ in, wall thickness $t = 0.25$ in, and maximum allowable shear stress $\tau_{max} = 10$ kpsi. Determine the appropriate value of internal pressure p_i . 7
- A carbon steel ball with 25-mm diameter is pressed together with an aluminum ball with a 40-mm diameter by a force of 10 N. Determine the maximum shear stress, and the depth at which it will occur for the aluminum ball. Assume that, a typical Poisson's ratio of 0.3, is applicable to estimate the depth at which the maximum shear stress occurs for these materials. 9²/₃

3. a) The basic size of a locational interference fit is 50 mm. The maximum and minimum hole dimensions are given as 50.025 mm and 50.000 mm respectively. The maximum and minimum shaft dimensions are given as 50.042 mm and 50.026 mm respectively. The materials are both hot-rolled steel ($\nu = 0.292$, $E = 207$ GPa). Find the maximum and minimum values of the radial interference and the corresponding interface pressure. Use a collar diameter of 100 mm.

7

b) The steel eyebolt shown in the figure 2 is loaded with a force $F = 300$ N. The bolt is formed from wire of diameter $d = 6$ 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 A-A.

9½

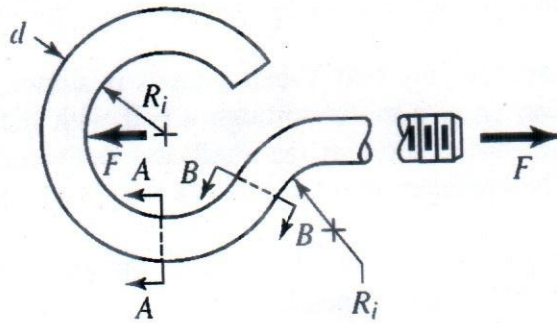


Fig: 2

4. The cantilevered bar in the figure 3 is made from a ductile material and is statically loaded with $F_x = 75$ lbf, $F_y = -200$ lbf and $F_z = 100$ lbf. Analyze the stress situation in rod AB by obtaining the following information.

16½

- Determine the precise location of the critical stress element.
- Determine magnitudes and directions for all stresses acting on the critical stress element.

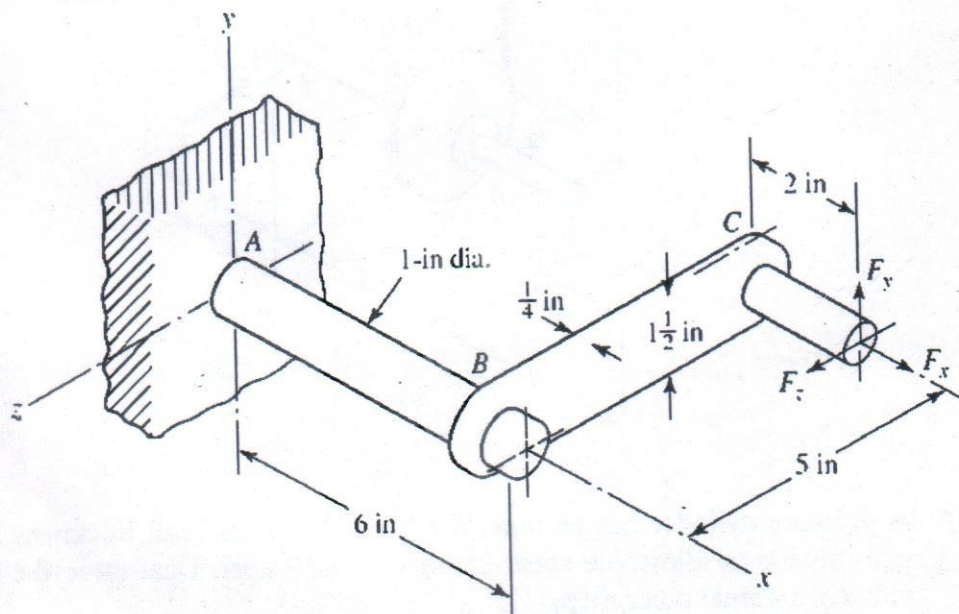


Fig: 3

Formulas for Sections of Circular Curved Beam

$$r_c = r_i + R$$

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

Formulas for Press and Shrink Fits

$$p = \frac{\delta}{R \left[\frac{1}{E_o} \left(\frac{r_o^2 + R^2}{r_o^2 - R^2} + \nu_o \right) + \frac{1}{E_i} \left(\frac{R^2 + r_i^2}{R^2 - r_i^2} - \nu_i \right) \right]}$$

$$p = \frac{E\delta}{2R^3} \left[\frac{(r_o^2 - R^2)(R^2 - r_i^2)}{r_o^2 - r_i^2} \right]$$

Formulas for Stresses in Pressurized Cylinders

$$\sigma_t = \frac{p_i r_i^2 - p_o r_o^2 - r_i^2 r_o^2 (p_o - p_i) / r^2}{r_o^2 - r_i^2}$$

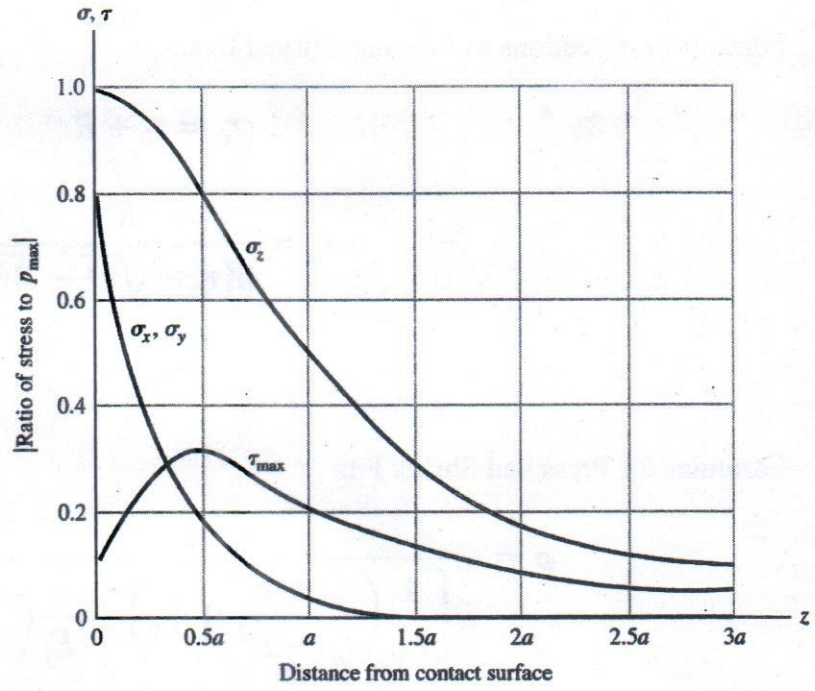
$$\sigma_r = \frac{p_i r_i^2 - p_o r_o^2 + r_i^2 r_o^2 (p_o - p_i) / r^2}{r_o^2 - r_i^2}$$

$$\sigma_t = \frac{r_i^2 p_i}{r_o^2 - r_i^2} \left(1 + \frac{r_o^2}{r^2} \right)$$

$$\sigma_r = \frac{r_i^2 p_i}{r_o^2 - r_i^2} \left(1 - \frac{r_o^2}{r^2} \right)$$

Figure 3-37

Magnitude of the stress components below the surface as a function of the maximum pressure of contacting spheres. Note that the maximum shear stress is slightly below the surface at $z = 0.48a$ and is approximately $0.3p_{max}$. The chart is based on a Poisson ratio of 0.30. Note that the normal stresses are all compressive stresses.



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

Mid Semester Examination
Course Code: Math 4611
Course Title : Numerical Analysis

Summer Semester: A.Y. 2017-2018
Time : 1½ Hours
Full Marks : 75

**There are 4 (four) questions. Answering of question 1 is compulsory.
Answer any 2 (two) questions from remaining 3 (three) questions.
Assume any missing data.**

1. a) You are working as a crime-scene investigator and must predict the temperature of a homicide victim over a 5-hr period. You know that the room where the victim was found was at 10°C when the body was discovered. Use *Newton's law of cooling* and *Euler's method* to compute the victim's body temperature for the 5-hr period using values of $k = 0.12/\text{hr}$ and time step size of 0.5 hr. Assume that the victim's body temperature at the time of death was 37°C, and that the room temperature was at a constant value of 10 °C over the 5-hr period. [15]

Newton's law of cooling says that the temperature of a body changes at a rate proportional to the difference between its temperature and that of the surrounding medium (the ambient temperature) and is given by the equation-

$$\frac{dT}{dt} = -k(T - T_a).$$

where, T = the temperature of the body (°C), t = time (hour), k = the proportionality constant (per hour), and T_a = the ambient temperature (°C).

- b) Use zero- through third-order Taylor series expansions to predict $f(3)$ for [10]
 $f(x) = 25x^3 - 6x^2 + 7x - 88$
using a base point at $x = 1$. Compute the true percent relative error ϵ_t for each approximation.
2. a) Use bisection method to determine the time at which the velocity of a parachutist becomes 30 [10]
m/s. The velocity of the parachutist, as a function of time, is given below.
 $v(t) = 53.44 (1 - e^{-0.18355 t})$
Use initial guesses of *lower limit* = 4 s and *upper limit* = 5.5 s and iterate until the approximate relative error falls below 5%.

- b) You are designing a spherical tank (Figure 01) to hold water for a [15]
small village in a developing country. The volume of liquid it can hold can be computed as

$$V = \pi h^2 \frac{[3R - h]}{3}$$

where V = volume [m^3], h = depth of water in tank [m], and
 R = the tank radius [m]

If $R = 3$ m, what depth must the tank be filled to so that it holds 30 m^3 ? Use Newton-Raphson method with a starting guess of 10 m and use the stopping criterion of 4% approximate relative error.

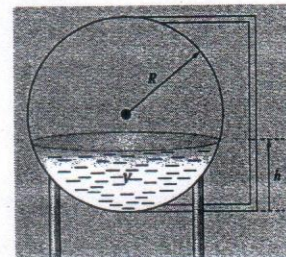


Figure 01

3. a) The specific growth rate g of a yeast that produces an antibiotic is a function of the food concentration c : [12]

$$g = \frac{2c}{4 + 0.8c + c^2 + 0.2c^3}$$

Find the value of c at which growth is a maximum. Use the golden-section search with *lower limit* = 1 and *upper limit* = 3. Use stopping criterion of 5% approximate relative error.

- b) A finite-element model of a cantilever beam subject to loading and moments (Figure 02) is given by optimizing [13]

$$f(x, y) = 5x^2 - 5xy + 2.5y^2 - x - 1.5y$$

where, x = end displacement and y = end moment. Find the values of x and y that minimize $f(x, y)$. Use gradient search with initial guess $(x, y) = (2, 2)$ and $h = 0.2$ (h is the distance along h axis). Show calculations upto 5 iterations.

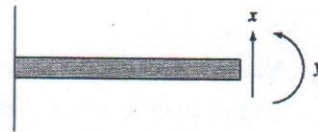


Figure 02

4. a) The following data for the density of nitrogen gas versus temperature come from a table that was measured with high precision. Use Newton's interpolating polynomials of order 1 through 4 to estimate the density at a temperature of 330 K. [13]

T, K	200	250	300	350	400
Density, kg/m ³	1.708	1.367	1.139	.967	.854

- b) The following function describes the temperature distribution on a rectangular plate for the range $-2 \leq x \leq 0$ and $0 \leq y \leq 3$ [12]

$$T = 2 + x - y + 2x^2 + 2xy + y^2$$

Find the temperatures at the four corners $(-2, 0)$, $(0, 0)$, $(-2, 3)$, $(0, 3)$. Use bilinear interpolation to predict the temperature value at $(x, y) = (-1.63, 1.627)$ using these four corner values. Find the error between the actual value and predicted value.

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

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

Summer Semester: A.Y. 2017-2018
TIME: 1 1/2 Hours
Full Marks: 75

There are 4 (Four) Questions. Answer any 3 (Three) 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. Derive the differential convection equations in the boundary layers for *steady*, [25]
two-dimensional flow considering concurrent heat and mass transfer.

2. a) What is the physical significance of the Prandtl number? Does the value of the [04]
Prandtl number depend on the type of flow or the flow geometry? Does the
Prandtl number of air change with pressure? Does it change with temperature?

- b) What are the advantages of non-dimensionalizing the convection equations? [03]

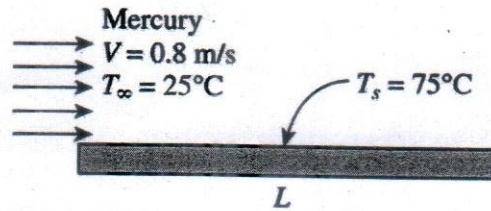
- c) Experiments have shown that, for airflow at $T_{\infty} = 35^{\circ}\text{C}$ and $V_1 = 100$ m/s, the [08]
rate of heat transfer from a turbine blade of characteristic length $L_1 = 0.15$ m and
surface temperature $T_{s,1} = 300^{\circ}\text{C}$ is $q_1 = 1500$ W. What would be the heat
transfer rate from a second turbine blade of characteristic length $L_2 = 0.3$ m
operating at $T_{s,2} = 400^{\circ}\text{C}$ in airflow of $T_{\infty} = 35^{\circ}\text{C}$ and $V_2 = 50$ m/s?

- d) It is observed that a 230-mm-diameter pan of water at 23°C has a mass loss rate [10]
of 1.5×10^{-5} kg/s when the ambient air is dry and at 23°C .
 - (i) Determine the convection mass transfer coefficient for this situation.
 - (ii) Estimate the evaporation mass loss rate when the ambient air has a
relative humidity of 50%.
 - (iii) Estimate the evaporation mass loss rate when the water and ambient
air temperatures are 47°C , assuming that the convection mass transfer
coefficient remains unchanged and the ambient air is dry.

For Saturated water vapor ($T_s = 296\text{K}$): $v_g = 49.4$ m³/kg, ($T_s = 320$ K): $v_g =$
 13.98 m³/kg.

3. a) Consider laminar flow of air across a hot circular cylinder. At what point on the [03]
cylinder will the heat transfer be highest? What would your answer be if the flow
were turbulent?

- b) Mercury at 25°C flows over a 3-m-long and 2-m-wide flat plate maintained at [11]
 75°C with a velocity of 0.8 m/s. Determine the rate of heat transfer from the
entire plate.

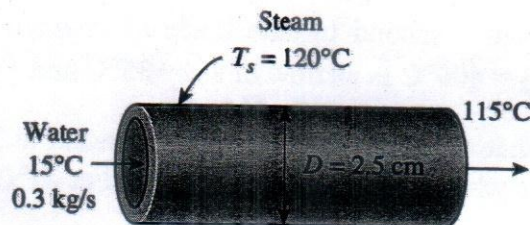


The properties of mercury at 50°C are $k = 8.83632 \text{ W/m}^\circ\text{C}$, $\nu = 1.056 \times 10^{-7} \text{ m}^2/\text{s}$, $\text{Pr} = 0.0223$.

- c) Consider a sphere with a diameter of 20 mm and a surface temperature of 60°C [11] that is immersed in a fluid at a temperature of 30°C and a velocity of 2.5 m/s. Calculate the drag force and the heat rate when the fluid is (a) water and (b) air at atmospheric pressure. Explain why the results for the two fluids are so different.

Consider the following properties: Water: ($T_\infty = 303\text{K}$), $\mu = 8.034 \times 10^{-4} \text{ Ns/m}^2$, $\nu = 8.068 \times 10^{-7} \text{ m}^2/\text{s}$, $k = 0.6172 \text{ W/mK}$, $\text{Pr} = 5.45$; Water ($T_s = 333\text{K}$): $\mu_s = 4.674 \times 10^{-4} \text{ Ns/m}^2$; Air: ($T_\infty = 303\text{K}$, 1 atm): $\mu = 1.86 \times 10^{-5} \text{ Ns/m}^2$, $\nu = 1.619 \times 10^{-5} \text{ m}^2/\text{s}$, $k = 0.0265 \text{ W/mK}$, $\text{Pr} = 0.707$; Air ($T_\infty = 333\text{K}$): $\mu_s = 2.002 \times 10^{-5} \text{ Ns/m}^2$.

4. a) What is the physical significance of the number of transfer units NTU? What do small and large NTU values tell about a heat transfer system? [03]
 b) Discuss the development of velocity and thermal boundary layer in a pipe. [12]
 c) Water enters a 2.5-cm-internal-diameter thin copper tube of a heat exchanger at 15°C at a rate of 0.3 kg/s, and is heated by steam condensing outside at 120°C . If the average heat transfer coefficient is $800 \text{ W/m}^2\text{-K}$, determine the length of the tube required in order to heat the water to 115°C . Specific heat of water at 65°C is 4187 J/kg-K , Heat of condensation of steam at 120°C is 2203 kJ/kg [10]



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

Mid Semester Examination
 Course No: HUM 4617
 Course Title: Engineering Management

Summer Semester, A. Y. 2017-2018
 Time : 1½ hours
 Total Marks : 75

There are **FOUR(4)** questions. Answer any **THREE(3)** of them.
 Figures in the right margin indicate full marks.
 Programmable Calculators are not allowed. Do not write on this question paper.

1. (a) What do you understand by Management? Describe functions of Management. If you were the Chief Executive of an educational institution, mention the functions you would do with respect to management. [14]
- (b) Write down Fayol's Fourteen Principles of Management and briefly explain any seven of them [11]
2. (a) Describe Islamic Management Framework for a leader. If you were the CEO of a company, how would you use it? Explain. [10]
- (b) Unplanned shutdown is a chronic problem in factories. In a manufacturing plant, after much discussion, consensus reached to the points that 'oil leakage' and 'human errors' as the primary causes. A diagnostic approach based on the fact was introduced. The table provides data on the causes of past shutdowns: [15]
- | <i>Causes</i> | <i>Frequency</i> |
|-----------------------|------------------|
| Oil leakage | 33 |
| Human error | 16 |
| Cooling failure | 65 |
| Initiator System | 25 |
| Interlock malfunction | 19 |
| Others | 23 |
- Convert the data into Pareto table and draw a Pareto diagram. Then find the vital few and comment about the consensus versus fact.
3. (a) Briefly describe any two change management strategies. If you were the Head of a Traffic Police Department, how would you try to ensure traffic rule compliance using any two change management strategies? [4+8]
- (b) Describe 'Six Thinking Hats' decision support method with an example. [13]
4. (a) Describe Maslow's need hierarchy theory. If you were appointed as the chief executive officer (CEO) of a power plant, how would you motivate the employees in light of this theory? Make the necessary assumptions. [17]
- (b) Describe SWOT analysis with an example. [8]

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DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid-Semester Examination

Summer Semester, A.Y. 2017-2018

Course No. MCE 4621/MCE 4691

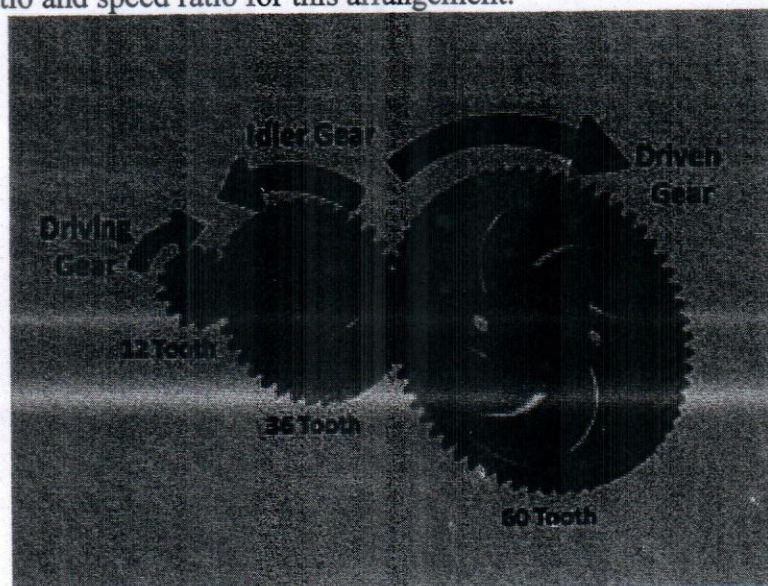
TIME : 1½ Hours

Course Title: Machine Tools

Full Marks : 75

There are 4 (FOUR) Questions. Answer any 3 (THREE) of them.
Marks in the Margin indicate the full marks.

-
- 1 a) Stating the steps of an engineering process, explain how these can be used in producing any mechanical drives. 6
- b) Explain the meaning of mechanical drives by diagram and state the shortcomings of these drives over pneumatic or hydraulic drives. 7
- c) Why is idler pulley used in belt drives? Show at least two schematic diagrams on idler pulleys used in outside and inside. 7
- d) Why is maintenance important in using belt drives? State five key maintenance issues. 5
- 2 a) In a pneumatic system, a compressor has to run at 300 rpm and it requires 100 kW power. The compressor is connected to an electric motor by a belt drive. The belt speed should remain at 1,500 m/min. The diameter of the compressor side pulley is 1 m and the center distance between the pulleys is 1.8 m. Determine the number of belts required if the cross-sectional area of each belt is 375 mm² and density is 990 kg/m³ and allowable tensile stress is 2.6 MPa. If the groove angle between the pulleys is 35° and coefficient of friction is 0.25, determine the length of each belt. Show the schematic diagram of the arrangement and exhibit all calculations. 20
- b) Suppose there is required to design a compound belt drive. Show the arrangement by a diagram. What would be the velocity ratio in mathematical form? 5
- 3 a) What is mechanical advantage in an engineering system? Explain this by any real-world mechanism. 7
- b) Is the following arrangement is a compound gear train? Why or why not? Find the gear ratio and speed ratio for this arrangement. 8



- c). Using the following gear chart, find the output torque if the input torque is 20 N-m and output speed of a gear set if the input speed is 2,500 rpm. Take any combination of a gear set from the chart. 10

		Input gear: No. of teeth			Ratio
		40	80	120	
Output gear: No. of teeth	40	1.0	0.5	0.3	Torque ratio
		1.0	2.0	3.0	Speed ratio
	80	2.0	1.0	0.7	Torque ratio
		0.5	1.0	1.5	Speed ratio
	120	3.0	1.5	1.0	Torque ratio
		0.3	0.7	1.0	Speed ratio

- 4 a) There are charts in different machines to set the proper speed for cutting different materials. Explain how to position the gear sets for certain speed. Use a structural diagram. 7
- b) Distinguish between pneumatics and hydraulics. Give some practical examples on the use of these systems. 6
- c) What is a pneumatic system, State its constituents and with a schematic diagram explain how a pneumatic system works. 12

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ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination
Course No.: MCE 4627
Course Title: Tool Engineering

Summer Semester, A. Y. 2017-2018
Time: 1 Hour 30 Min(s)
Full Marks: 75

There are 4 (Four) questions. Answer any 3(Three) questions.

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

-
- | | | |
|-------|---|----|
| 1. a) | What is Morphological Chart Method? How this method is used to generate alternative design solutions of a product? | 10 |
| b) | Explain in details the new design process using rational method and hence show that rational method is mapped on to a cross's model. | 15 |
| 2. a) | Explain with neat sketches the Merchant's model for orthogonal cutting and find out the optimum value of the shear angle. | 10 |
| b) | Explain the different tool life criterion and how can it be calculated using Taylor tool life method? | 09 |
| c) | A pipe was orthogonally machined with a tool of 20° rake angle where the chip length was measured 80 mm and uncut chip length was 198 mm. Determine the shear plane angle and the chip thickness if the depth of cut is 0.75 mm. | 06 |
| 3. a) | Why chip breaker is used? Explain the different types of chip breakers and hence discuss with the schematic illustration of the action of a chip breaker? | 10 |
| b) | Draw the different elements of a twist drill and hence explain the different types of webs, margins and helix angles features used in a twist drill. | 15 |
| 4. a) | Explain briefly the mechanism of locating a work-piece and hence explain the 3-2-1 locating principle. | 15 |
| b) | What are the differences in between the Jigs and fixture? Explain briefly the different factors for the design of jigs and fixtures. | 10 |

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DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

MID SEMESTER EXAMINATION SUMMER SEMESTER: 2017-2018
Course No: MCE-4653 TIME : 1HR 30 MIN
Course Name: Air Conditioning FULL MARKS: 75

There are Four Questions. Answer any Three Questions.
 Assume reasonable value for missing data. Figures in the margin indicate full marks.

1. a) What do you understand by the term "Psychrometry"? Define i) Specific humidity, ii) Relative humidity and iii) Dew point temperature. (10)
- b) Atmospheric air at 40°C DBT and 18°C WBT is flowing at the rate of 100 m³/min through the space. Water at 18°C is injected into the air stream at the rate of 48 kg/h. Determine specific humidity and enthalpy of the leaving air. Also determine the DBT, WBT and relative humidity of the leaving air. (15)
2. 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 human being 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)
3. 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°C DBT, 50% RH	SHG of glass ; 300 W/m ²
Outside conditions: 43°C DBT, 24°C 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°C	Infiltration: 0.5 ACH
CLTD for roof: 30°C	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 and sensible heat. What will be the required cooling capacity?

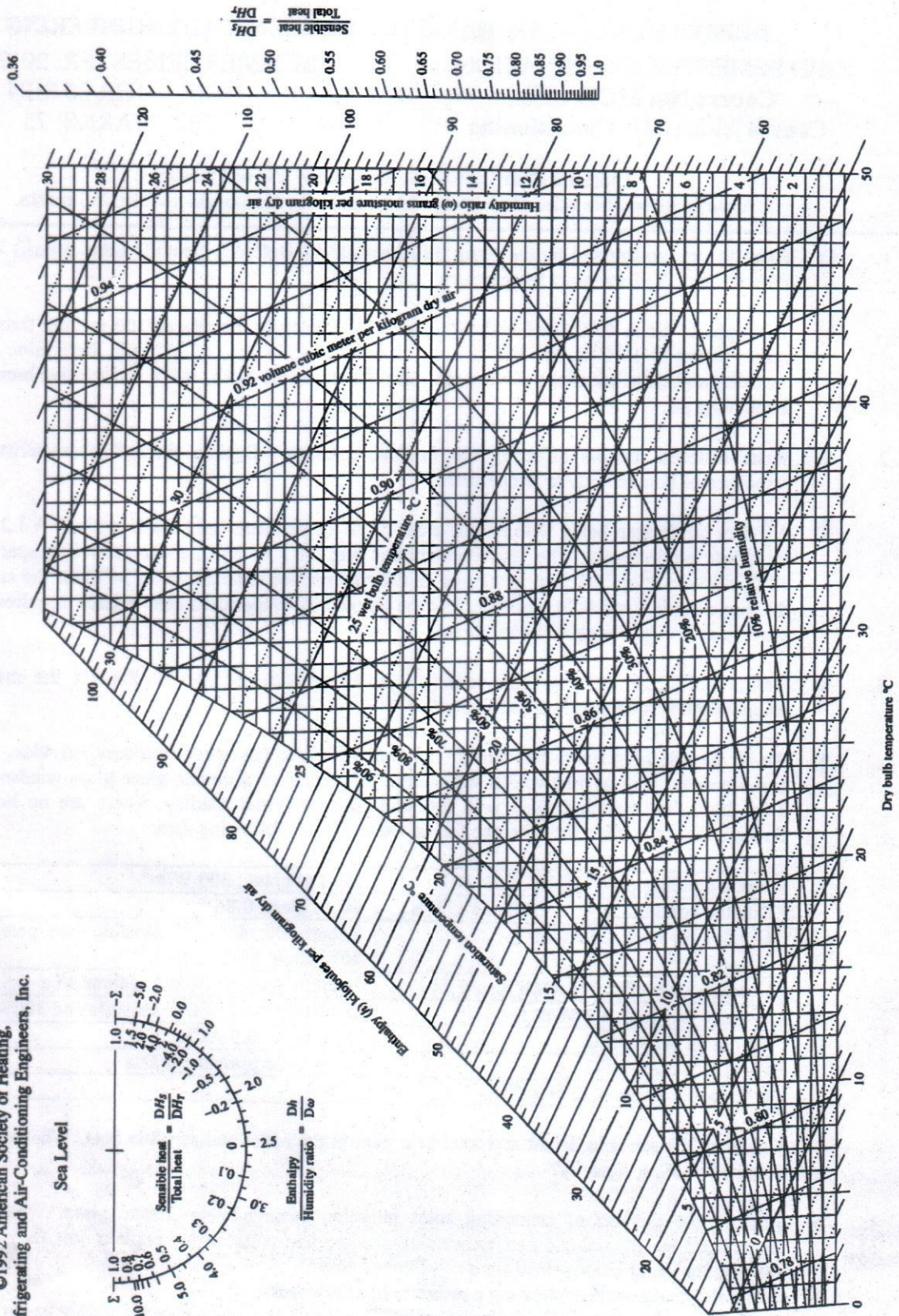
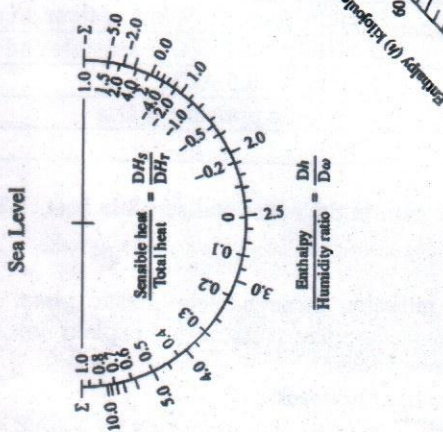
4. a) Explain the method of estimating solar radiation through clear plastic glass. What do you understand by internal and external shading of the glass window and explain how they impart in the calculation of cooling load for a conditioned space. (15)
- b) Write short note on the following psychrometric processes: (10)
 - (i) Heating of moist air, (ii) cooling of moist air and (iii) Humidification by adding steam

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



ASHRAE Psychrometric Chart No. 1
Normal Temperature
Barometric Pressure: 101.325 kPa

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DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid-Semester Examination

Course Code: MCE 4663

Course Title: **Automatic Control Engineering**

Summer Semester A.Y. 2017-2018

Time : 1.5 hours

Full Marks : 75

There are 4(Four) Questions. Answer any 3(Three) of them.

Assume reasonable data if necessary.

Programmable calculators are not allowed. Don't write on this question paper.

1. a) Represent the following rotational system (Fig.1) in **state space**, where $\theta_3(t)$ is the output. (15)

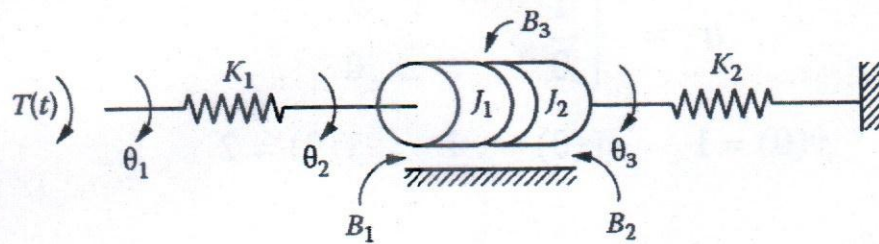


Fig.1

- b) Determine the *transfer function* for the mechanical system (Fig. 2) shown below, with force f as input and displacement x as output. All other symbols have their usual meanings. (10)

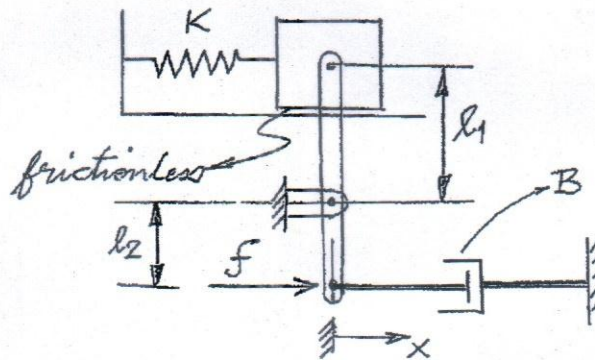


Fig. 2

2. Derive a suitable mathematical model for the following *Hydraulic actuator* (Fig. 3) which is controlling the position of a mass-spring-damper system. (25)

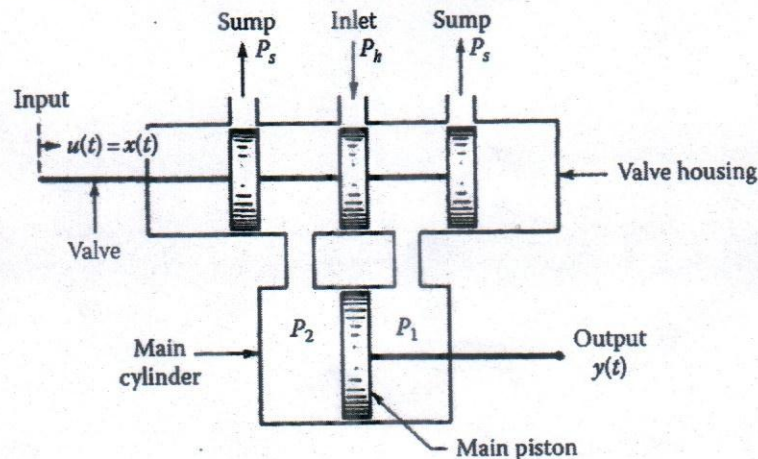


Fig. 4

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

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

- a) Find the equilibrium value(s) of $u(t) = u_{equil}$ corresponding to an operating speed of $v(t) = 100$ rad/sec.
- b) Find the *linearized* ordinary differential equation about the equilibrium point found in part (a).
4. Using the *Laplace Transform*, obtain the *time response* for the following system subject to the input and initial conditions specified below (25)

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

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

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

Laplace transform table

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

Laplace transform theorems

Item no.	Theorem	Name
1.	$\mathcal{L}[f(t)] = F(s) = \int_0^{\infty} f(t)e^{-st} dt$	Definition
2.	$\mathcal{L}[kf(t)] = kF(s)$	Linearity theorem
3.	$\mathcal{L}[f_1(t) + f_2(t)] = F_1(s) + F_2(s)$	Linearity theorem
4.	$\mathcal{L}[e^{-at}f(t)] = F(s+a)$	Frequency shift theorem
5.	$\mathcal{L}[f(t-T)] = e^{-sT}F(s)$	Time shift theorem
6.	$\mathcal{L}[f(at)] = \frac{1}{a}F\left(\frac{s}{a}\right)$	Scaling theorem
7.	$\mathcal{L}\left[\frac{df}{dt}\right] = sF(s) - f(0^-)$	Differentiation theorem
8.	$\mathcal{L}\left[\frac{d^2f}{dt^2}\right] = s^2F(s) - sf(0^-) - f'(0^-)$	Differentiation theorem
9.	$\mathcal{L}\left[\frac{d^n f}{dt^n}\right] = s^n F(s) - \sum_{k=1}^n s^{n-k} f^{(k-1)}(0^-)$	Differentiation theorem
10.	$\mathcal{L}\left[\int_0^t f(\tau) d\tau\right] = \frac{F(s)}{s}$	Integration theorem
11.	$f(\infty) = \lim_{s \rightarrow 0} sF(s)$	Final value theorem ¹
12.	$f(0^+) = \lim_{s \rightarrow \infty} sF(s)$	Initial value theorem ²

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DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

MID SEMESTER EXAMINATION

SUMMER SEMESTER: 2017-2018

Course No: MCE-4685

TIME : 1HR 30 MIN

Course Name: Automotive Technology(II)

FULL MARKS: 75

There are Four Questions. Answer any Three Questions.

Figures in the Margin indicate full marks. Do not write on this question paper.

- 1 a) Elucidate the construction, primary components and working principle of Macpherson Strut Suspension system with fully labeled diagrams. And also, briefly explain the difference between Torsion bar and Stabilizer bar suspension system. (13)
- b) What is Transaxle? How do we differentiate between transmission and transaxle? (4)
- c) Why do the front engine FWD vehicles have CV joints instead of U joints on front drive axle? Provide brief explanation with primary reasons. (8)
What are Synchronizers? Explain their objectives in manual power transmission?
- 2 a) Briefly explain the operational principle and components installed in front and rear drive suspension system. (8)
- b) How the mechanical operated linkage clutch and hydraulic operated clutch systems are differentiated based on their components and operational principle? Provide detailed explanation with proper diagrams. (12)
- c) Differentiate the construction and working of diaphragm and coil spring pressure plate. (5)
- 3 a) Elaborate the Transmission power flow of seven speed transmission with individual labeled schematic diagrams. Write down the significance of installing spur gears instead of helical gears in reverse gear system? (12)
- b) Write down the classification of power transmission arrangement and provide proper schematic diagrams. (5)
- c) What are the primary suspension system components? Explain the allocation of leaf spring and shock absorber on rear drive axle with labeled schematic diagrams. (8)
- 4 a) Briefly explain the primary components of Gearshift mechanism in manual power transmission system. (5)
- b) Draw a graph for demonstration of drive shaft yoke speed fluctuations. Explain the construction and working principle of Rzeppa Joint and double-Cardan joint with fully labeled diagrams. (10)
- c) Why do we install Limited slip differential instead of conventional differential gear box? Briefly explain the construction and working principle of limited slip differential gear box with labeled diagrams. (10)

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DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

MID SEMESTER EXAMINATION

SUMMER SEMESTER: 2017-2018

Course No: MCE 4687

TIME : 1HR 30 MIN

Course Name: Automotive Maintenance
Engineering (II)

FULL MARKS: 75

There are Four Questions. Answer any Three Questions.
Figures in the Margin indicate full marks. Do not write on this question paper.

- 1 a) Write down the difference between Caster angle and Toe. Provide detailed explanation of Steering axis inclination and Thrust line alignment with schematic diagrams. (12.5)
- b) How the radial movement of ball joint is measured on a Macpherson strut Front Suspension system. Provide necessary steps. (12.5)
- 2 a) Write down the proper identification, examination and diagnosis of any three Clutch problems. How the bleeding of Hydraulic operated Clutch system is diagnosed? Explain. (15)
- b) Elaborate the guidelines to be followed while working on the maintenance of clutch assembly. (10)
- 3 a) Write down the Diagnosis and maintenance for FWD driveline with primary problems, possible causes and corrective remedies. (12.5)
- b) Provide detailed explanation for troubleshooting of Transmission/Transaxle in manual transmission system. (12.5)
- 4 a) How the measurement and adjustment of Backlash and Side-bearing Preload on a final drive assembly is made? Provide crucial steps. (12.5)
- b) Write down the thorough explanation for diagnosis and inspection of CV joints. Briefly explain the maintenance steps for servicing of U-joints. (12.5)

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 DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

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

Summer Semester: A.Y. 2017-2018
 TIME: 1 1/2 Hours
 Full Marks: 75

There are 4 (Four) Questions. Answer any 3 (Three) Questions.

Figure in the Margin indicate full marks. Don't write on this question paper. Symbols carry their usual meanings. Assume reasonable values for any missing data. Programmable calculators are not allowed.

1. a) Construct a *load curve* and a *load duration curve* for a typical Summer day for [15]
 your hall of residence (North/South hall) in IUT with realistic *load data*. Clearly
 state your assumptions.
- b) For construction of a *load curve*, what are the different *factors* used? Briefly [10]
 elaborate with their definitions.

2. a) Draw the *flow diagram* for a *triple extraction regenerative cycle* with [12]
 corresponding *T-s diagram*. Write down the equation for *thermal efficiency* for
 the same.
- b) With the help of a diagram, discuss the importance of *Departure from Nucleate* [06]
Boiling for safe operation of steam generators.
- c) What are the different types of *thermal insulation materials* used in steam [07]
 generators? Briefly elaborate on *thermal insulation design*.

3. a) Distinguish between *Convective Superheater/Reheater* and *Radiant* [08]
Superheaters/Reheaters in terms of arrangement, steam flow and steam
 temperature.
- b) Discuss the effects of 3 *Ts* for complete combustion. [06]
- c) With the help of a figure, discuss the *forced convection boiling* in a *once-through* [08]
boiler. How do you calculate the *heat transfer* during this process?
- d) Discuss the effects of *burner backlash* and *burner blow-off* on *flame stability*. [03]

4. a) Briefly elaborate different properties of *liquid fuels* which determines its uses in [15]
 different applications.
- b) Discuss the factors that affect *pulverizer-grinding* performance along with its [10]
 processing capacity.

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

Mid Semester Examination
Course Code: MCE 4821
Course Title: Design for Manufacturing

Summer Semester, A.Y. 2017-2018
Time : 1½ hours
Full Marks : 75

There are 4 (Four) Questions. Answer any 3 (Three) of them.

Marks in the Margin indicate the full marks.

- 1 a) Define the term Design for Manufacturing and explain with flow diagram the different steps for the implementation of DFM method. 15
b) Explain briefly the general principles for design of production? 10
- 2 a) What do you mean by concurrent engineering? Explain briefly how does concurrent engineering reduce time for product development? 10
b) Explain the term quality deployment function and hence explain briefly how the method is used to reflect customer needs to be transferred into product and process characteristics. 15
- 3 a) Explain with the flow diagram the Failure Mode and Effect Analysis (FMEA) process for system improvement? 12
b) Explain with example the term Project Prioritization Index [PPI] and hence explain how FMEA is combined with PPI to improve problem solving technique. 08
c) Write down the different applications and benefits for FMEA method? 05
- 4 a) Define the term Design for quality and explain the different dimensions of quality for a manufactured part. 08
b) Explain briefly the different strategies that need to be implemented for the design of quality 11
c) Explain the term cost of quality and show that how prevention cost reduce the total quality cost of a product. 06

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

Mid Semester Examination
Course No MCE 4827
Course Title: Production Planning and Control

Summer Semester, A. Y. 2017-2018
Time : 1½ hours
Full Marks : 75

There are 4 (Four) questions. Answer any 3 (Three) of them.

Marks in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper. Some formulas are provided at the end of this question paper.

1. a) The new Agro-based facility is targeted to serve seven census tracts in a country. The table given below shows the coordinates for the centre of each census tract, along with the projected populations, measured in thousands. Customers will travel from the seven census tract centres to the new facility when they need health-care. Find out the location of the proposed new agro-based facility using centre of gravity method. [10]

Sl no	Census Tract	(x, y)	Population(I)
1	A	(2.5, 4.5)	2
2	B	(2.5, 2.5)	5
3	C	(5.5, 4.5)	10
4	D	(5, 2)	7
5	E	(8, 5)	10
6	F	(7, 2)	20
7	G	(9, 2.5)	14

- b) The number of daily sales of cars from BMT Automobile Ltd during the first week of June 2018 is provided below. [15]
- Prepare an exponential smoothing forecast of each day. Assume any alpha (α) value as deemed appropriate.
 - Find error, absolute error, MAD, and the tracking signal for each day.
 - Using MAD and tracking signal, comment on the forecast.

Date	No of Cars sold
1 June 2018	17
2 June 2018	21
3 June 2018	27
4 June 2018	30
5 June 2018	12
6 June 2018	29
7 June 2018	32

2. a) A store sells a certain brand of Drill Jig which has the following characteristics: [15]
 Average annual sales = 500 units
 Ordering cost = 35 dollar per order, Carrying interest rate = 15% per year
 Item cost = 300 dollar per unit, Lead time = 6 days
 Standard deviation of daily demand = 0.1 unit
 Working days per year = 290
 i) Determine the Economic Order Quantity (EOQ)
 ii) Calculate the Reorder point (R) for a 85 percent service level
 iii) State the Q rule (continuous review system) for this item.
 iv) Determine Target Inventory (T) and Period (P) for P (Periodic review) system of inventory for 90% service level.
 v) State P rule (Periodic review system) for this item.
- b) Find 4-weeks weighted moving average forecasts for demand from the following table. [10]

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

3. a) The activities associated with the production planning of a company are given in the following table. [20]
 i) Find the critical path for the project using forward pass and backward pass.
 ii) Find out free float and total float for any two activities.
 iii) If you delay a noncritical activity more than free float but less than the total float, what would be the impact on the other activities after it?
 iv) Draw time schedule also known as Gantt chart for this project showing the critical and non critical activities.

Name of the activity	Description	Immediate Predecessor(s)	Duration(days)
A	Forecast sales volume	-	10
B	Study competitive market	-	7
C	Design item and facilities	A	5
D	Prepare production schedule	C	3
E	Estimate cost of production	D	2
F	Set sales price	B, E	1
G	Prepare budget	F	14

- b) Derive Economic Order Quantity (EOQ) formula. [5]
4. a) An engineer sets three criteria for the selecting a car for his personal use. These three criteria are: Reliability (R), Mileage (M) and Advance safety system (A). Two cars, one is called H and the other is P, are suggested by a car dealer. The engineer prefers A three times more important than R ; A four times more than M, and M two times more than R. Furthermore, according to R, he prefers H three times more than P. According to M, he prefers P four times more than H. According to A, he prefers P two times more than H. Using Analytical Hierarchy Process (AHP), determine which car the engineer should select. [20]
- b) If you were in charge of deciding about pricing for a pump produced by ZX company located in Riyadh, which pricing strategy would you choose? Explain. [5]

Formulas MCE 4827

$$C_x = \frac{\sum d_{ix} V_i}{\sum V_i}$$

$$C_y = \frac{\sum d_{iy} V_i}{\sum V_i}$$

Normal Demand Percentages

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

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

Mid-Semester Examination Summer Semester, A.Y. 2017-2018
 Course No. MCE 4829 TIME : 1½ Hours
 Course Title: Industrial Management Full Marks : 75

There are 4 (FOUR) Questions. Answer any 3 (THREE) of them.
 Marks in the Margin indicate the full marks.

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- 1 a) The ABET definition of Engineering has a close matching to produce the desired engineers by Islamic University of Technology (IUT). Citing the definition explain the statement. 6
- b) State the steps of an engineering process. By a figure state the methodology on identification of engineering problems. 8
- c) What is meant by Key Results Area (KRA) or core values? State the key results area according to Peter F. Drucker. Which ones of them are tangible and how? 7
- d) Mention at least five logical learning techniques. 4
- 2 a) Is industrial management for manufacturing or production synonymous? Give reasons in favor of your answers. 5
- b) What are the key characteristics of an organization? In a diagram show the levels and scope of managers. State the roles of management of an organization. 10
- c) Suppose you are going to introduce a new production plant. What skills and competencies should you possess with in operating it efficiently and effectively? 10
- 3 a) State the general features of planning in industrial management. 5
- b) IUT management is thinking to draw a strategic plan. What are the steps it must consider? In light of it as an organ of OIC, what should be its main vision and mission? What other key things would you like to suggest? Use diagram if necessary. 10
- c) One main goal of Japanese production system is elimination or minimization of waste. From your religious and production perspectives, explain the statement. 10
- \ Name the categories of wastes defined by Toyota Production System (TPS).
- 4 a) What do you understand by decision analysis? Explain the decision environments using the relevant diagram and mathematical expressions. 10
- b) XYZ company is going to introduce one of the three new products: widget, hand-phone set or a mini-computer. The possible market conditions are: favorable, stable, or unfavorable will determine the profit or loss the company realizes, as shown in the following payoff table. 15

Product	Market conditions and their probabilities		
	Favorable 0.2	Stable 0.7	Unfavorable 0.1
Widget	Tk360,000	210,000	-90,000
Hand-phone set	180,000	120,000	60,000
Mini-computer	105,000	90,000	90,000

- i. Compute the expected value for each decision and select the best one.
- ii. Determine how much the firm would be willing to pay to a market research firm to gain better information about future market conditions.
- iii. Assume that probabilities cannot be assigned to future market conditions, and determine the best decision using the maximax, maximin, minimax regret, and equally likelihood criteria.

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

Semester Mid-term Examination
 Course No. MCE 4839/MCE 4895
 Course Title: Mechatronics

Summer Semester, A.Y. 2017-2018
 TIME : 1.5 Hours
 Full Marks : 75

There are 4 (Four) Questions. Answer any 3(Three) Questions.
 Marks in the margin indicate full marks.

- 1 a) What do you mean by Electrical Network? What are the basic elements of the network? (3)
- b) Write short notes on active elements, passive elements, bilateral elements and unilateral elements and linear circuit and non-linear circuit. (3)
- c) Describe Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL) (6)
- d) For the circuit shown in Figure 1. find the current through IAB, IAC, ICD, and IEF using 'mesh current' method. (13)

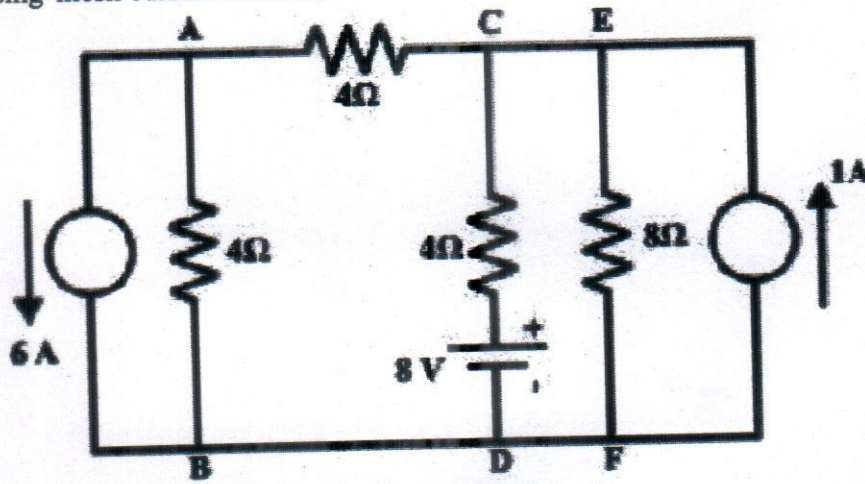


Figure 1

- 2 a) State the theorem of Superposition. When this theorem is most often used? (6)
- b) Describe the procedure for using the Superposition theorem. (4)
- c) Using Superposition theorem, find the current i through 5Ω resistor as shown in Figure 2 (15)

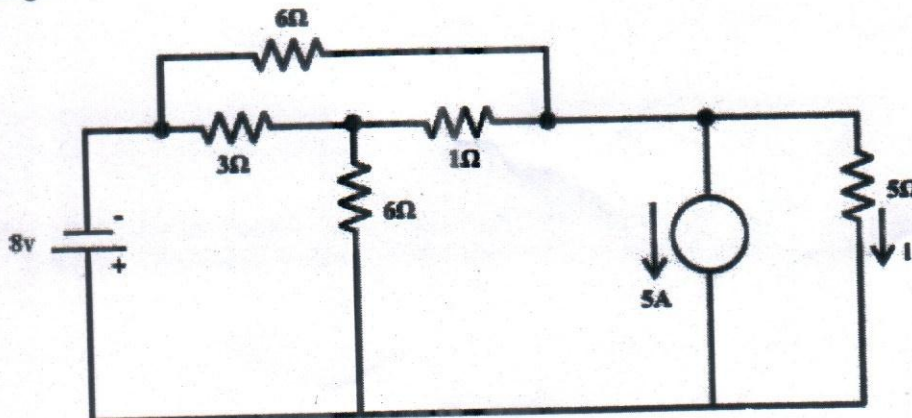


Figure 2

- 3 a) Describe the construction of a diode. Draw its water analogy. (4)
- b) Describe how it works and how it does not works. (6)
- c) Write short notes on half wave rectifier, full wave rectifier and AC to DC power supplier converter. (15)

- 4 a) Write the working principle of a limit switches. (4)
- b) What are their functions and applications (6)
- c) Write down the working principle of inductive, capacitive and optical sensor. (15)

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

Mid Semester Examination
 Course No. MCE 6161
 Course Title: Advanced Control Engineering

Winter Semester, A.Y. 2017-2018
 TIME : 1 Hour 30 Minutes
 Full Marks : 75

There are 4 (Four) Questions. Answer any 3(Three) Questions.

Marks in the margin indicate full marks.

1. a) With the help of an example explain the general block diagram of an industrial control system. Write down the objectives of the control system. 12
- b) What do you mean by industrial control system modeling. Write down the steps of modeling. Using the examples of mass spring and damper system explain the general procedure of state variable method. 13
2. a) What are the conditions of using impulse response method. Using the example of rotation of an object with a flexible shaft explain the standard form of a second order system. Draw the dynamic response curve for different values of damping factor ζ . 25
3. Use the Routh criterion to determine the number of roots in the left half plane, right half plane and on the imaginary axis for the given characteristics equation: 25

$$s^7 + 5s^6 + 9s^5 + 9s^4 + 4s^3 + 20s^2 + 36s + 36$$
4. a) Write down the pole-zero form of transfer function. Explain the terms system gain, poles and zeroes. Explain the dynamic response curve for different positions of poles in S-plane and define the conditions of stability. 25

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

Mid Semester Examination

Course No.: MCE 6421

Course Title: Robotics and Manufacturing Automation

Summer Semester, A. Y. 2017-2018

Time: 1 Hours 30 Min(s)

Full Marks: 75

There are 4 (Four) questions. Answer any 3 (Three) questions.

All questions carry equal marks/Marks in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper.

1. a) Briefly discuss the following advanced automation functions: 15
 - i) Safety monitoring
 - ii) Maintenance and repair diagnostics
 - iii) Error detection and recovery
- b) What is the difference between a closed-loop control system and an open-loop control system? 10
2. a) What is the difference between a continuous variable and a discrete variable? 15
Name and briefly define each of the three different types of discrete variables.
- b) What is the difference between an event-driven change and a time-driven change in discrete control? 10
3. a) For 3.8 V what is the digital output by using a Successive-Approximation ADC? 15
Also calculate the error. (6-bit A/D with range 0V – 5V)
- b) What is the difference between an analog sensor and a discrete sensor? 10
4. a) Draw the circuit diagram of a 4 bit binary weighted DAC and explain how does it work? 15
- b) What is an interlock? What are the two types of interlocks in industrial control? 10

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

Mid Semester Examination

Summer Semester, A.Y. 2017-2018

Course Code: MCE 6497

Time : 1½ hours

Course Title: Engineering Economics

Full Marks : 75

There are 4 (Four) Questions. Answer any 3 (Three) of them.

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

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

$$F = P(1+i)^n$$
- b) Describe MARR and rule of 72 with numeric examples 10
- c) Write down two differences between Crowd Funding and Angel Investors. 10
 Describe any two types of crowd funding methods.
2. a) A company that manufactures compressors is trying to decide between the machines shown below. Compare them on the basis of their Present Worth(PW) values, using an interest rate of 12% per year 15

	Machine A	Machine B
First cost, \$	270,000	320,000
Annual Operating Cost, \$/year	200,000	300,000
Onetime overhauling cost in year 3, \$	Not Applicable	26,000
Onetime overhauling cost in year 2, \$	140,000	Not Applicable
Servicing cost, \$	\$ 400 at year 2 and then increases by \$50 every year	\$ 200 at year 3 and then increases by 2% every year
Salvage value	19,000	30,000
Life, years	6	9

- b) Describe Peer to Peer(P2P) financing with an example. 10
3. a) Compare the alternatives shown below on the basis of their Present Worth(PW) over the planning horizon of 5 years, using an interest rate of 12% per year and provide a decision about which one of them should be selected. 20

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

- b) Write down two main differences between Limited Companies and Cooperatives. 5

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

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

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

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

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Formula:

Geometric gradient:

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

12%

Compound Interest Factors

12%

n	Single Payment		Uniform Payment Series				Arithmetic Gradient		n
	Compound Amount Factor	Present Worth Factor	Sinking Fund Factor	Capital Recovery Factor	Compound Amount Factor	Present Worth Factor	Gradient Uniform Series	Gradient Present Worth	
	Find F Given P F/P	Find P Given F P/F	Find A Given F A/F	Find A Given P A/P	Find F Given A F/A	Find P Given A P/A	Find A Given G A/G	Find P Given G P/G	
1	1.120	.8929	1.0000	1.1200	1.000	0.893	0	0	1
2	1.254	.7972	.4717	.5917	2.120	1.690	0.472	0.797	2
3	1.405	.7118	.2963	.4163	3.374	2.402	0.925	2.221	3
4	1.574	.6355	.2092	.3292	4.779	3.037	1.359	4.127	4
5	1.762	.5674	.1574	.2774	6.353	3.605	1.775	6.397	5
6	1.974	.5066	.1232	.2432	8.115	4.111	2.172	8.930	6
7	2.211	.4523	.0991	.2191	10.089	4.564	2.551	11.644	7
8	2.476	.4039	.0813	.2013	12.300	4.968	2.913	14.471	8
9	2.773	.3606	.0677	.1877	14.776	5.328	3.257	17.356	9
10	3.106	.3220	.0570	.1770	17.549	5.650	3.585	20.254	10
11	3.479	.2875	.0484	.1684	20.655	5.938	3.895	23.129	11
12	3.896	.2567	.0414	.1614	24.133	6.194	4.190	25.952	12
13	4.363	.2292	.0357	.1557	28.029	6.424	4.468	28.702	13
14	4.887	.2046	.0309	.1509	32.393	6.628	4.732	31.362	14
15	5.474	.1827	.0268	.1468	37.280	6.811	4.980	33.920	15
16	6.130	.1631	.0234	.1434	42.753	6.974	5.215	36.367	16
17	6.866	.1456	.0205	.1405	48.884	7.120	5.435	38.697	17
18	7.690	.1300	.0179	.1379	55.750	7.250	5.643	40.908	18
19	8.613	.1161	.0158	.1358	63.440	7.366	5.838	42.998	19
20	9.646	.1037	.0139	.1339	72.052	7.469	6.020	44.968	20
21	10.804	.0926	.0122	.1322	81.699	7.562	6.191	46.819	21
22	12.100	.0826	.0108	.1308	92.503	7.645	6.351	48.554	22
23	13.552	.0738	.00956	.1296	104.603	7.718	6.501	50.178	23
24	15.179	.0659	.00846	.1285	118.155	7.784	6.641	51.693	24
25	17.000	.0588	.00750	.1275	133.334	7.843	6.771	53.105	25
26	19.040	.0525	.00665	.1267	150.334	7.896	6.892	54.418	26
27	21.325	.0469	.00590	.1259	169.374	7.943	7.005	55.637	27
28	23.884	.0419	.00524	.1252	190.699	7.984	7.110	56.767	28
29	26.750	.0374	.00466	.1247	214.583	8.022	7.207	57.814	29
30	29.960	.0334	.00414	.1241	241.333	8.055	7.297	58.782	30
31	33.555	.0298	.00369	.1237	271.293	8.085	7.381	59.676	31
32	37.582	.0266	.00328	.1233	304.848	8.112	7.459	60.501	32
33	42.092	.0238	.00292	.1229	342.429	8.135	7.530	61.261	33
34	47.143	.0212	.00260	.1226	384.521	8.157	7.596	61.961	34
35	52.800	.0189	.00232	.1223	431.663	8.176	7.658	62.605	35
40	93.051	.0107	.00130	.1213	767.091	8.244	7.899	65.116	40
45	163.988	.00610	.00074	.1207	1358.2	8.283	8.057	66.734	45
50	289.002	.00346	.00042	.1204	2400.0	8.304	8.160	67.762	50
55	509.321	.00196	.00024	.1202	4236.0	8.317	8.225	68.408	55
60	897.597	.00111	.00013	.1201	7471.6	8.324	8.266	68.810	60
65	1581.9	.00063	.00008	.1201	13173.9	8.328	8.292	69.058	65
70	2787.8	.00036	.00004	.1200	23223.3	8.330	8.308	69.210	70
75	4913.1	.00020	.00002	.1200	40933.8	8.332	8.318	69.303	75
80	8658.5	.00012	.00001	.1200	72145.7	8.332	8.324	69.359	80
85	15259.2	.00007	.00001	.1200	127151.7	8.333	8.328	69.393	85
90	26891.9	.00004		.1200	224091.1	8.333	8.330	69.414	90
95	47392.8	.00002		.1200	394931.4	8.333	8.331	69.426	95
100	83522.3	.00001		.1200	696010.5	8.333	8.332	69.434	100

15%

Compound Interest Factors

15%

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