BSc. Engg. (M) 1st Sem | 05 March 2019 (Afternoon)

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

MID SEMESTER EXAMINATION
Course No: MCE-4101
Course Name: Introduction to Mechanical Engineering

Winter Semester: 2018-2019
TIME : $1^1/_2$ HRS
FULL MARKS: 75

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

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1. a) Briefly explain the limitations of non-conventional forms of energy in the context of the present world energy scenario? How potential they are in mitigating energy crisis that the world will have to face in the next century? (10)

   b) Explain the coal grading processes. Make a detailed discussion on Proximate and Ultimate analysis of the solid fuel to find the percent of its constituents. (15)

2. a) Write some characteristic properties of the Natural Gas. Explain the transformation process of dead plants and animal to different forms (solid, liquid and gas) of useful energy. (10)

   b) "Hydro energy is the most consistent form of the renewable energy amongst others"- Justify this statement through elaborative discussions. (15)

3. a) Explain the different forms of energy available in the Ocean. (10)

   b) Explain with necessary diagrams the working principle of an OTEC system. An OTEC system has to have a larger sized plant" why and justify your answer. (15)

4. a) What is crude oil and how it is formed through natural processes? What do you mean by the unit "Barrel" used for crude oil? What fractions of gasoline and diesel are derived from One Barrel of Crude Oil? Explain the separation processes with necessary diagrams? (10)

   b) How the energy derived from biomass fuel? Explain with neat sketch a simple biogas plant. (15)

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B.Sc. Engg. (M) -1st Sem. 04 March 2019 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

MID SEMESTER EXAMINATION
Course No: **MCE-4103**
Course Name: **Engineering Mechanics**

WINTER SEMESTER: 2017-2018
TIME : **1HR 30 MINS**
FULL MARKS: **100**

There are **Four** Questions. Answer any **Three** Questions. All questions carry equal marks.
Assume reasonable value for missing data.

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1 **(a)** Determine the resultant force acting on the hook shown in ***Figure 1a***.

(b) The winch on the truck is used to hoist the garbage bin onto the bed of the truck as depicted in ***Figure 1b***. If the loaded bin has a weight of **8500 lb** and center of gravity at ***G***, determine the force in the cable needed to begin the lift. The coefficients of static friction at ***A*** and ***B*** are $\mu_A = 0.3$ and $\mu_B = 0.2$, respectively. Neglect the height of the support at ***A***.

2 **(a)** The mast ***OA*** is supported by three cables illustrated in ***Figure 2a***. If cable ***AB*** is subjected to a tension of ***500N,*** Determine the tension in cable ***AC*** and ***AD*** and the vertical force ***F*** which the mast exerts along its axis on the collar at ***A***.

(b) Both pulleys are fixed to the shaft and as the shaft turns with constant angular velocity, the power of pulley ***A*** is transmitted to pulley ***B*** which has been shown in ***Figure 2b.*** Determine the horizontal tension ***T*** in the belt on pulley ***B*** and the x, y, z components of reaction at the journal bearing ***C*** and thrust bearing ***D*** if $\theta = 45^o$.The bearings are in proper alignment and exert only force reactions on the shaft.

3. **(a)** Determine the moments of inertia of the shaded area shown in ***Figure 3a*** with respect to the **x** and **y** axes when **a = 20 mm**.

(b) Wet concrete exerts a pressure distribution along the wall of the form demonstrated in ***Figure 3b***. Determine the resultant force of this distribution and specify the height ***h*** where the bracing strut should be placed so that it lies through the line of action of the resultant force. The wall has a width of **5 m**.

4 **(a)** Locate the centroid *(x, y)* of the shaded area ***Figure 4(a)*** bounded by two curves $y = x$ and $y = \frac{x^3}{9}$.

(b) Locate the center of mass of the composite assembly shown in ***Figure 4(b)*** The conical frustum has a density of $\rho_c = 10 Mg/m^3$, and the hemisphere has a density of $\rho_h = 5\ Mg/m^3$. There is a 30-mm-radius cylindrical hole in the center of the frustum.

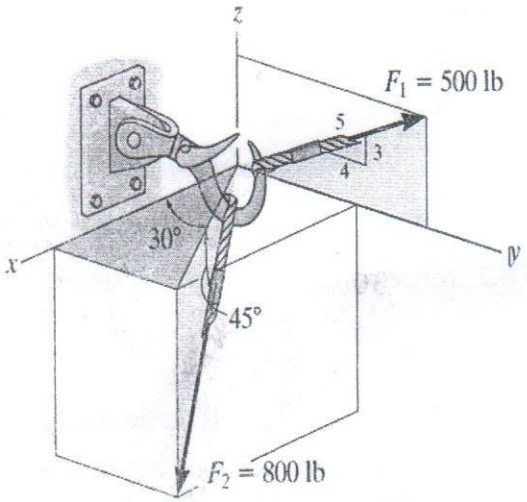

Figure-1a

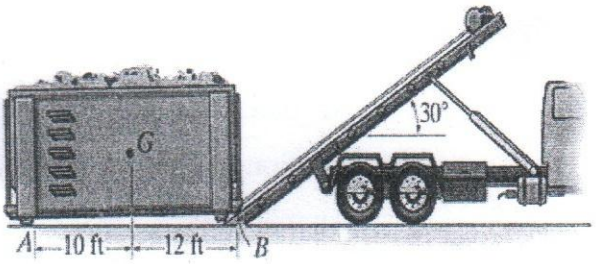

Figure-1b

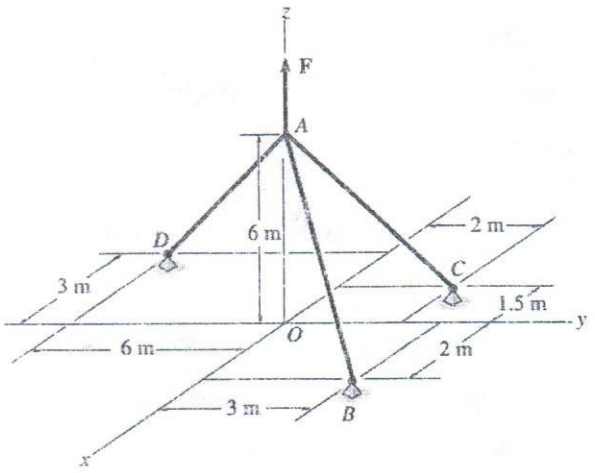

Figure-2a

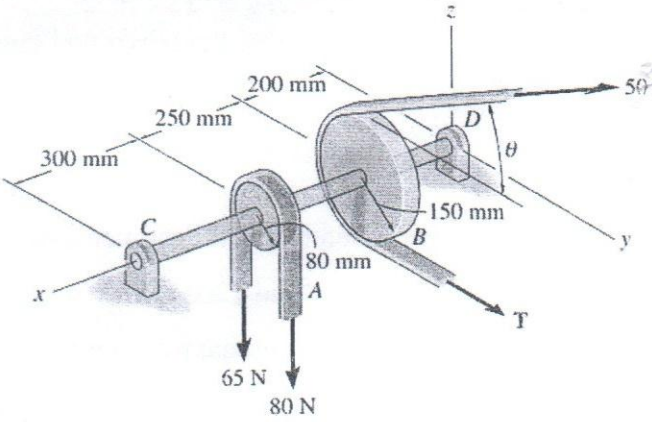

Figure-2b

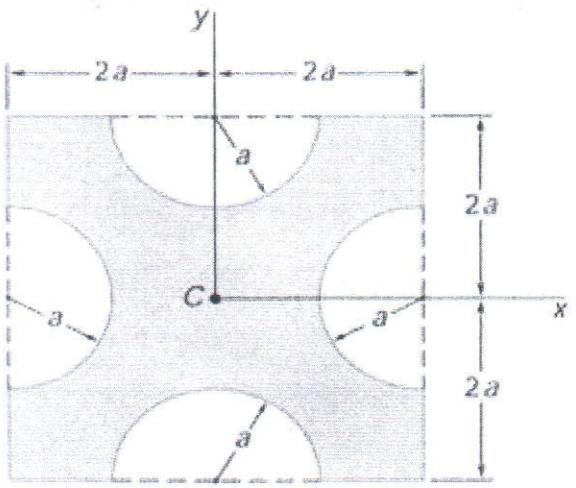

Figure-3a

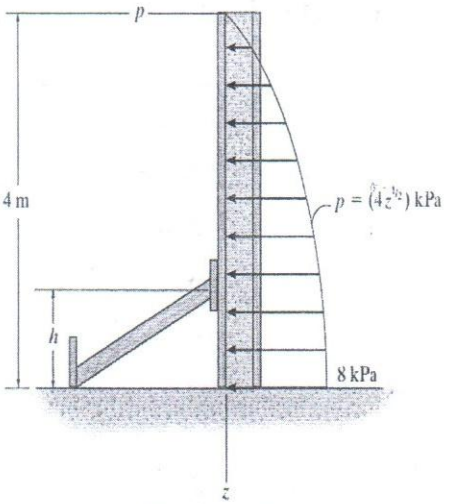

Figure-3b

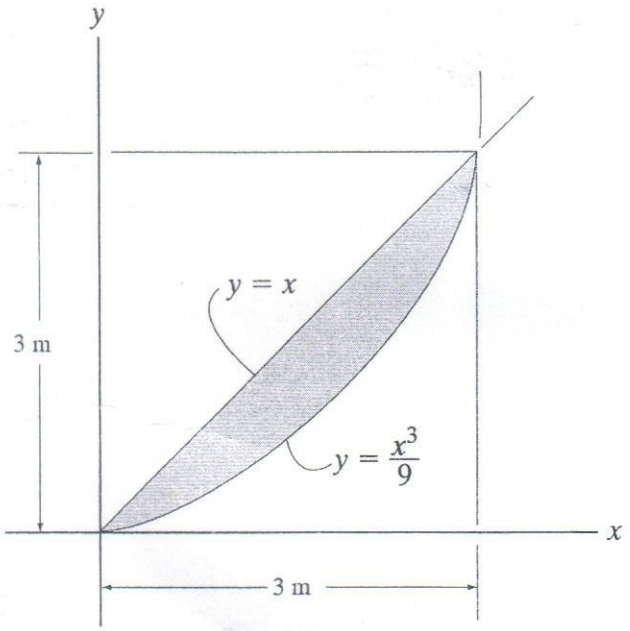

Figure-4a

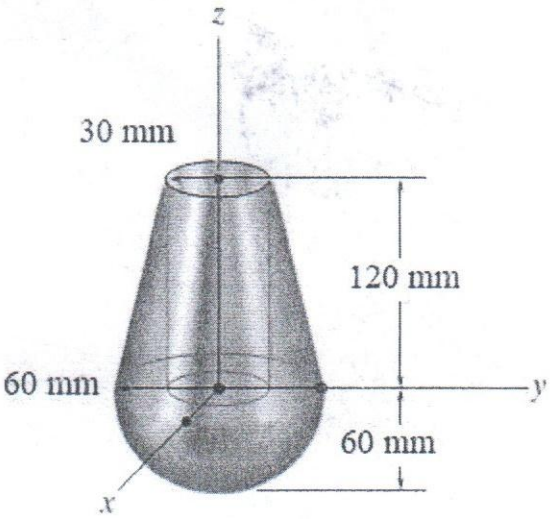

Figure-4b

B Sc. Eng.(M)(1st Semester) 11 March, 2019(Afternoon)

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

Mid Semester Examination — Winter Semester, A.Y. 2018-2019
Course Code: Math 4111 — Time : 1½ hours
Course Title: Solid Geometry, Differential and Integral Calculus — Full Marks: 100

There are **4 (Four)** Questions. Answer any **3 (Three)** of them. Marks in the right margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper. The Symbols have their usual meaning.

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1. a) Find a formula for each function graph shown in Figure 01 and 02: **13⅓**

(i)

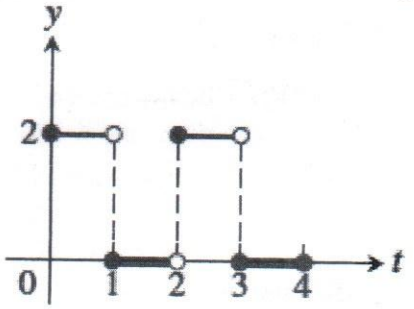

Figure: 01

(ii)

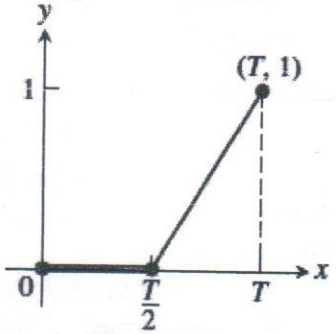

Figure: 02

b) Figure 03 shows the graph of a function $f(x)$ with domain [0, 2] and range [0, 1]. Find the domains and ranges of the following functions, and sketch their graphs. **20**

$(i)\ -f(x)\quad (ii)\ f(x)+2\quad (iii)\ f(x-1)\quad (iv)\ -f(x+1)+1$

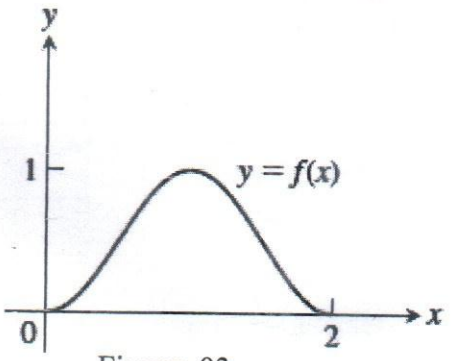

Figure: 03

2. a) **10**

A function $f(x)$ is defined $f(x)=\begin{cases}\sqrt{1-x}, & 0\le x<1\\ 1, & 1\le x<2\\ 2, & x=2\end{cases}$

Graph the function and answer the following questions.
(i) What are the domain and range of f?
(ii) At what points c, if any, does $\lim_{x\to c} f(x)$ exist?
(iii) At what points does only the left-hand limit exist?
(iv) At what points does only the right-hand limit exist?

b) (i) What are horizontal and vertical asymptotes? Give examples. **13**

(ii) Find the horizontal and vertical asymptotes of the graph of the function

$$f(x)=\frac{\sqrt{2x^2+1}}{3x-5}$$

c) A dynamite blast blows a heavy rock straight up with a launch velocity of *160 ft/sec.* It reaches a height *of* $s = 160t - 16t^2$ *ft* after t sec. **10⅓**

(i) How high does the rock go?

(ii) What are the velocity and speed of the rock when it is 256 *ft* above the ground on the way up? On the way down?

(iii) What is the acceleration of the rock at any time t during its flight (after the blast)?

(iv) When does the rock hit the ground again?

3. a) If $y=\tan^{-1}x$ prove that $(1+x^2)y_2+2xy_1=0$ and deduce that **10⅓**

$(1+x^2)y_{n+2}+2(n+1)xy_{n+1}+n(n+1)y_n=0$ hence determine $(y_n)_0$

b) Suppose S represents weekly sales of a product. Write down the interpretation of S and S' for each of the following statements? **10**

(i) The rate of change of sales is increasing.

(ii) The rate of change of sales is constant.

(iii) Sales are steady.

c) Find the critical points of $f(x) = (x^2 - 3)e^x$. Identify the open intervals on which f is increasing and decreasing. Find the function's local and absolute extreme values. **13**

4. a) Figure 04 shows an offshore oil well located at a point W that is 5 *km* from the closest point A on a straight shoreline. Oil is to be piped from W to a shore point B that is 8 *km* from A by piping it on a straight line under water from W to some shore point P between A and B and then on to B via pipe along the shoreline. If the cost of laying pipe is Tk.1,000,000/*km* under water and Tk.500,000/*km* over land, where should the point P be located to minimize the cost of laying the pipe? **15**

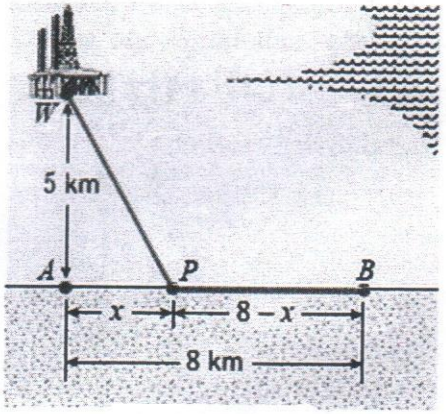

Figure: 04

b) (i) What is the equation of the tangent line approximation to the graph of a function f at the point *(c, f (c))?* **18⅓**

(ii) Find the linearization of the function $f(x)=\sqrt{x+3}$ at $a = 3$ and use it to approximate the numbers $\sqrt{3.98}$ and $\sqrt{40.5}$. Are these approximations overestimates or underestimates?

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B.Sc. Engg.(M)/ 1st Sem. 07 March, 2019(Afternoon)

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

Mid Semester Examination — Winter Semester 2018-2019
Course No. Phy 4113 — Time: 1½ Hrs.
Course Title: Structure of Matter, Electricity & Magnetism and Modern Physics — 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) State and explain Coulomb's law for electrostatic force. Show that the torque, $\tau = \mathbf{p} \times \mathbf{E}$, and the potential energy, $U = -\mathbf{p}.\mathbf{E}$, of an electric dipole in a uniform electric field, where the symbols have their usual meanings. (4 + 14)
   (b) The magnitude of the two opposite charges of a dipole placed in a uniform electric field is 4×10^{-5} C. The charges are separated by a distance 10.0 mm. Calculate the maximum torque exerted by the electric field on the dipole and find the potential energy of the system when the dipole is rotated from 0° to 90°. (7)
2. (a) What do you understand by electric flux? State and explain Gauss's law in electrostatics and hence obtain Coulomb's law of electrostatic force between electric charges from it. (4 + 14)
   (b) Find an expression for the electric field strength, E due to an infinite line of charge, q applying Gauss's law. (Linear charge density=λ(C/m)) (7)
3. (a) Define capacitance of a capacitor. Show that the induced surface charge, q′ is always less in magnitude than the free charge, q when a parallel plate capacitor is filled with a dielectric of dielectric constant κ and hence obtain the Gauss's law for dielectrics in a capacitor. (4 + 14)
   (b) A parallel plate capacitor has circular plates of diameter 20 cm, separated by a distance 1.0 mm. Compute (i) the amount of charge stored on each plate when a potential difference of 100 V is applied across the places and (ii) the energy stored in the capacitor. (Assume no dielectric between the plates and $\varepsilon_o = 8.9 \times 10^{-12}$ C/N-m^2). (7)
4. (a) Derive the expressions for the growth and decay of charges when a capacitor is charged and discharged, respectively through a resistor connected in series to a DC source. What is capacitive time constant? (15 + 3)
   (b) A capacitor of capacitance 300 μF and a resistor of 1000 Ω are connected in series to a battery of 50 V. Calculate the time constant and the final charge, q_o on a capacitor plates. (7)

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B.Sc. Eng. (MCE) 1st Semester — 8 March 2019 (Morning)

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

Mid Semester Examination — Summer Semester, A.Y. 2018-2019
Course Code: Chem 4115 — Time : 1.5 hours
Course Title: Chemistry of Engineering Materials — Full Marks : 75

There are **4 (four)** Questions. Answer any **Three**.
Marks in the Margin indicate the full marks.

1. a) What are the fundamental particles of an atom? Briefly describe them. **6**
   b) Discuss Bohr's theory of hydrogen atom. What modifications were proposed by Sommerfeld and why? **10**
   c) Derive the equation for calculating the Energy of electron in the orbit of hydrogen atom and calculate energy of the electron in the 4^{th}. Orbit. **9**

2. a) Name and define chemical bonds. Give a comparative picture of Ionic and Covalent compounds **10**
   b) Draw the molecular diagram of NO and CN and explain the bond order and magnetic properties of them. **10**
   c) Show the hybridization in carbon. **5**

3 a) What do you understand by the dual nature of electron? Derive de Broglie's equation and show it's implication. **6**
   b) Derive Schrodinger's wave equation and show the significance of Ψ and Ψ^2. **10**
   c) What are quantum numbers? What do they signify? Give the relationship between them. **9**

4 Write short notes on the following: **25**
   a) Rutherford atom model
   b) AUFBAU principle
   c) Pauli Exclusion and Hund's rule
   d) Sommerfeld's modification
   e) Isotopes and Isobars

B.Sc. Eng. (EEE) 1st Semester 8 March 2019 (Morning)

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

Mid Semester Examination — Winter Semester, A.Y. 2018-2019
Course Code: Chem 4121 — Time : 1.30 hours
Course Title: Engineering Chemistry — Full Marks : 75

There are **4 (Four)** Questions. Answer any **3 (three)** of them.
Use the graph paper wherever necessary. Marks in the Margin indicate the full marks.

1 a) What is enthalpy? Derive an equation for isothermal reversible expansion work done by a perfect gas. 9

b) Discuss briefly, ionization energy is a periodic function. What types of anomalies or irregularity are observed for ionization potential when you move through left side to the right side in the periodic table? Explain the reason of the above anomalies. 10

c) When 2.0 moles of ethane is completely burnt, 3129.0 kJ heat is liberated. Calculate the heat of formation of C_2H_6. The heats of formation of CO_2 (g) and H_2O (l) are – 393.0 and – 286.0 kJ mol^{-1}, respectively. 6

2 a) Describe the main features of Valence-Shell Electron-Pair Repulsion (VSEPR) model for predicting the shape of molecules (two, three and four electron pairs). Predict the shape of the following molecules according to VSEPR model (i) SiF_4, (ii) SF_4, (iii) XeF_4, and (iv) IF_5. 12

b) What is an ionic bond? What are the factors favouring the formation of ionic bonds? 5

c) Describe Molecular Orbital Theory (MOT). Draw the molecular orbital diagram of NO molecule. State the bond order and magnetic properties. 8

3 a) Derive Schrödinger's Wave Equation. What is the significance of wave function? 10

b) State and explain Pauli exclusion principle. State whether each of the following sets of quantum numbers is permissible for an electron in an atom. If a set is not permissible, explain why. 8

(i) $n = 1, l = 1, m_l = 0, m_s = +\frac{1}{2}$

(ii) $n = 3, l = 1, m_l = =2, m_s = =-\frac{1}{2}$

(iii) $n = 2, l = 1, m_l = 0, m_s = +\frac{1}{2}$

(iv) $n = 2, l = 0, m_l = 0, m_s = 1$.

c) Calculate the frequency, energy, and wavelength of the emitted photon corresponding to the spectral line of the lowest frequency in Lyman series in the spectrum of hydrogen atom, where $R_H = 109678\ cm^{-1}$, $h = 6.626 \times 10^{-27}$ erg.sec. 7

4 a) What is osmotic pressure? Derive van't Hoff equation of osmotic pressure. 6

b) What is colligative property of a dilute solution? Derive a relation between elevation of boiling point of a solution by the addition of nonvolatile solute and molar mass of the solute with the help of vapour pressure-temperature diagram. 12

c) The formula for low-molecular-mass starch is $(C_6H_{10}O_5)n$, where n averages 200.00. When 0.798 g of starch is dissolved in 100.0 mL of water solution, what is the osmotic pressure at 25^0C? 7

B.Sc. Engg (M) 3rd sem **12 March 2019 (Morning)**

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

Mid Semester Examination
Course Code: MCE 4305
Course Title : Basic Thermodynamics

Winter Semester: A.Y. 2018-2019
Time : $1\frac{1}{2}$ Hours
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.
Assume any missing data

1. a) Show the constant volume process and constant pressure process at same temperatures on a single T-S diagram. Which one has the higher slope? Explain with thermodynamic equation. **(10)**

   Show the isothermal and adiabatic processes on a single P-V diagram and explain why one curve is steeper than the other, using thermodynamic equation.

   b) A fluid is confined in a cylinder by a spring loaded frictionless piston so that the pressure in the fluid is a linear function of the volume (p= a+bv). The internal energy of the fluid is given by the following equation: U=33.5+3pv, where, a and b are constants, U is in kJ, p in kN/m^2 and v in m^3. If the fluid changes from an initial state of 1.7 bar, 0.03 m^3 to a final state of 4 bar, 0.06 m^3, with no work other than that done on the piston, find the direction and magnitude of the work and heat transfer. **(15)**

2. a) What is meant by steady flow? Apply steady flow energy equation to find the work done in a turbine. **(10)**

   b) The velocity and enthalpy of fluid at the inlet of a certain steady flow apparatus are 50 m/s and 2800 kJ/kg respectively. The enthalpy at the exit of apparatus is 2600 kJ/kg. The inlet is 30 m above the ground level and outlet is at the ground level. The apparatus is insulated. Find: **(15)**
      I. velocity of the fluid at the exit of the apparatus
      II. mass flow rate, if the area at inlet of apparatus is 0.09 m^2 and specific volume is 0.185 m^3/kg
      III. exit area of apparatus, if the specific volume at the exit of apparatus is 0.495 m^3/kg

3. a) Prove that pressure in static fluid varies linearly in vertical direction and is independent in horizontal direction. **(10)**

   b) "Carnot engine is 100% efficient". Is the statement true? Explain if it violates any of the laws of thermodynamics. **(5)**

   c) Prove that Carnot engine is the most efficient engine within the same extreme temperatures. **(10)**

4. a) From the energy equation applied to closed system for constant volume process and Joule's law, prove that change of internal energy is always given by $Q = m\,Cv\,(T_2-T_1)$. **(15)**

Prove that change in enthalpy in any process can be written as $\Delta H = m\,Cp\,(T_2-T_1)$. Apply this equation to the energy balance equation of constant pressure process in a closed system. (Symbols bear the usual meaning)

b) Consider a U-tube (figure 01) whose arms are open to the atmosphere. Now equal volumes of water and light oil (density=780 kg/m^3) are poured from different arms. A person blows from the oil side of the U-tube until the contact surface of the two fluids moves to the bottom of the U-tube, and thus the liquid levels in the two arms are the same. If the fluid height in each arm is 76.2 cm, determine the gage pressure the person exerts on the oil by blowing. **(10)**

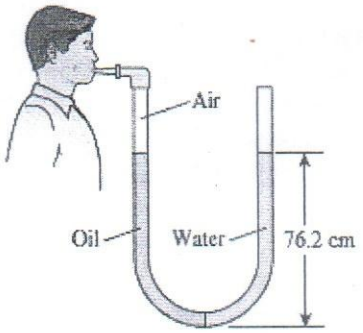

figure 01

BSc.Engg.(M)/3rdSem 11 March,2019 (Morning)

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

Mid SemesterExamination
Course Code:**MCE 4311**
Course Title: **Fluid Mechanics I**

Winter Semester :**A.Y. 2018-2019**
Time : **1.5Hours**
Full Marks : **100**

There are 04 (Four) Questions. Answer any 03 (Three) of them.
Do not write on the Question Paper. Figures in the Margin indicate the Full Marks.

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1. a) Define Co-efficient of Compressibility and Co-efficient of Volume expansion. [05]

   b) Prove that the sum of Kinetic, Potential and flow energies of fluid particle is constant along a streamline during steady flow when compressibility and frictional effects are negligible showing HGL and EGL in a pressurized pipe. [15]

   c) RMS Titanic sank in the early morning of 15 April 1912 in the North Atlantic Ocean, four days into the ship's maiden voyage from Southampton to New York City. The largest ocean liner in service at the time, Titanic had an estimated 2,224 people on board including *Jack Dawson* and *Rose DeWitt Bukater*. When she struck an iceberg at around 23:40 (ship's time) on Sunday, 14 April 1912. Her sinking two hours and forty minutes later at 02:20 (ship's time; 05:18 GMT) on Monday, 15 April, resulted in the deaths of more than 1,500 people, making it one of history's deadliest marine disasters during peacetime.Recently, a sonar study of the bow of the Titanic on the ocean floor has revealed that the holes caused by the iceberg are much smaller than originally thought. [13.33]

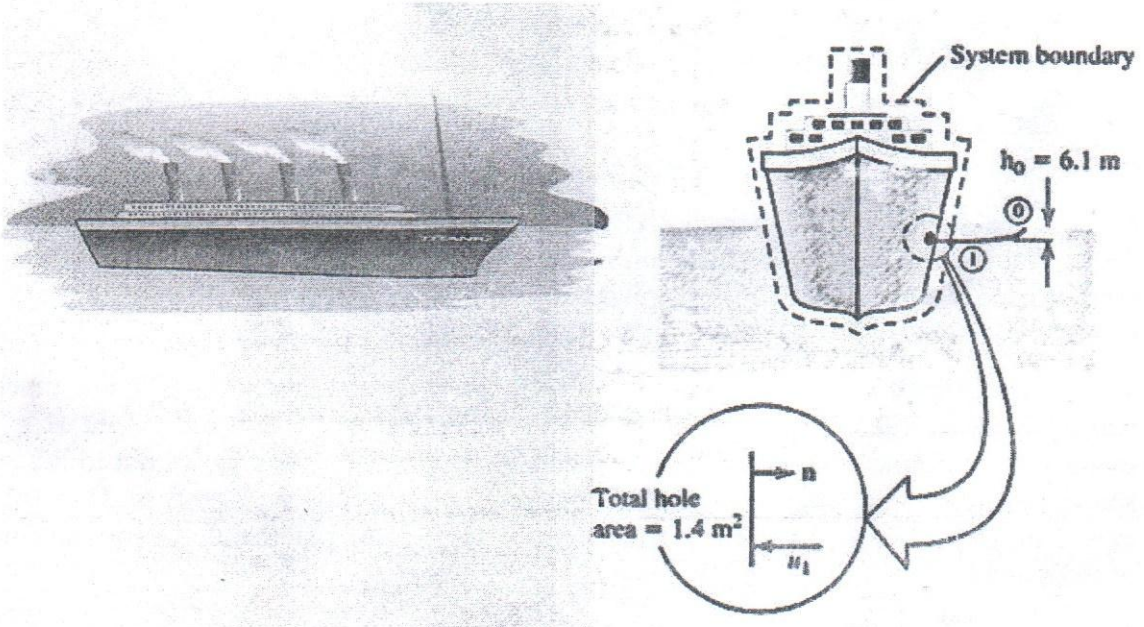

Figure 1

Until this study, it was assumed that a large, 100 m long gash was ripped in the Titanic's side, but now the sonar reveals that the area of the hole was only 1.4 m^2 (the size of a typical door) as shown in **Fig.1**. The hole of the Titanic was approximately 6.1 m below sea level at the start of the sinking. Was the hole large enough to sink the Titanic in 160 minutes? The dimensions of the ship were-length 269 m, maximum width 28 m, and height 30.5 m.

2. a) Define forced vortex motion and stagnation pressure. [05]

b) What is Conservation of Mass Principle? Derive an expression for Continuity Equation in 3D compressible, incompressible, steady and unsteady flow. [15]

c) A 20-cm-diameter, 60-cm-high vertical cylindrical container, shown in **Fig. 2**, is partially filled with 50-cm-high liquid whose density is 850 kg/m^3. Now the cylinder is rotated at a constant speed. Determine the rotational speed at which the liquid will start spilling from the edges of the container. [13.33]

3. a) Define No Slip Boundary condition and Boundary layer. [05]

b) Consider the top surface of a flat plate of arbitrary shape completely submerged in a liquid. The plane of this surface (normal to the page) intersects the horizontal free surface at angle θ. Determine the resultant hydrostatic force F_R acting on the surface and the line of action of the resultant force F_R. [15]

c) The pressure of water flowing through a pipe is measured by the arrangement shown in **Fig. 3**. For the values given, calculate the pressure in the pipe. All the liquids are incompressible. The effect of air column on pressure is negligible. [13.33]

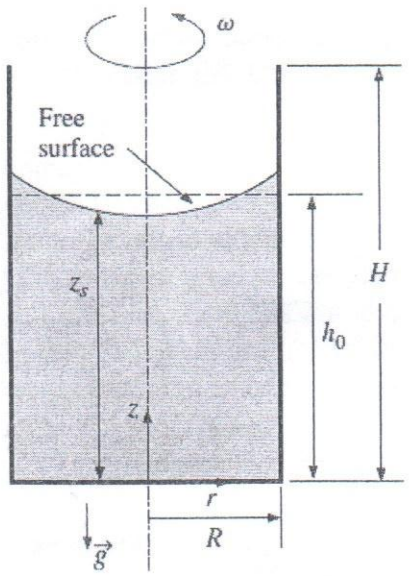

Figure 2

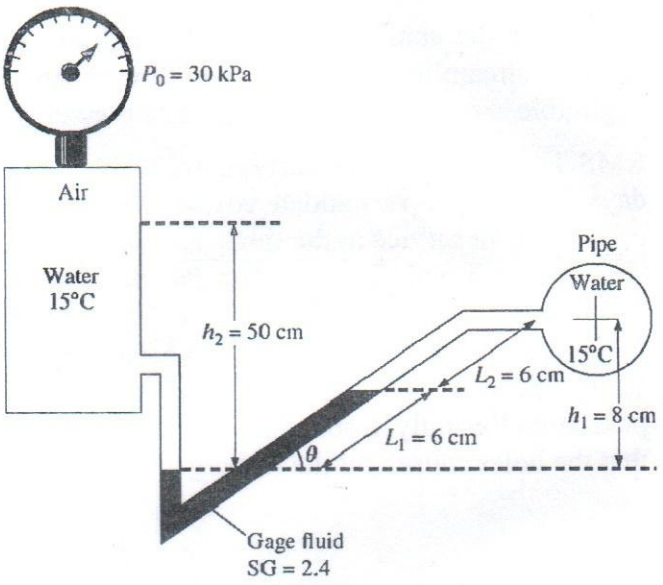

Figure 3

4. a) Define Newtonian and Non-Newtonian fluid. [05]

b) Discuss the stability of Immersed and Floating Bodies considering Metacentric Height. Prove that the buoyant force acting on a body of uniform density immersed in a fluid is equal to the weight of the fluid displaced by the body, and it acts upward through the centroid of the displaced volume. [15]

c) A horizontal pipeline is attached to the wall of reservoir as shown in **Fig. 4**. The pipeline has different profiles. The water level in the upper reservoir is in the height H = 1.5 mabove the pipeline axis. From the lower end of the pipeline water flows out to the open space. Diameters and lengths of pipeline reaches are: D_1 = 0.24 m, L_1 = 3 m, D_2 = 0.1 m, L_2 = 1 m, D_3 = 0.12 m, L_3 = 2 m. Calculate discharge in the pipeline and draw the course of EGL and HGL. Resolve the problem neglecting losses. [13.33]

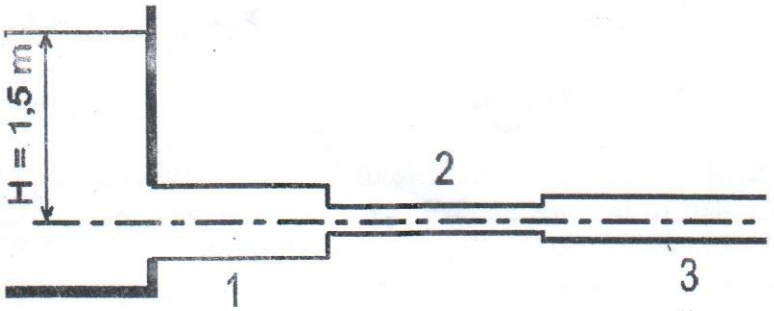

Figure 4

B Sc. Eng. (ME)(3rd Semester)/B Sc TE (2 Year, 1st Sem.) 07 March, 2019(Morning)

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

Mid Semester Examination — Winter Semester, A.Y. 2018-2019
Course Code: Math 4311/Math 4599 — Time : $1\frac{1}{2}$ hours
Course Title: Vector Analysis — Full Marks: 75

There are **4 (Four)** questions. Answer any **3 (Three)** out of them. All questions carry equal marks. Programmable calculators are not allowed. Do not write on this question paper. The symbols used have their usual meaning.

---

1. a) If V_1, V_2 are two non-collinear vectors, then every vector **r** coplanar with V_1 and V_2 can be uniquely represented as a linear combination $\alpha_1 V_1 + \alpha_2 V_2 = \mathbf{r}$, α_1, α_2 being scalars.

   b) If $\mathbf{a}+\mathbf{b}+\mathbf{c}=0$, $|\mathbf{a}|=3$, $|\mathbf{b}|=5$, $|\mathbf{c}|=7$, find the angle between **a** and **b**.

   c) A, B, C, D are the points $i-k$, $-i+2j$, $2i-3k$, $3i, -2j-k$ respectively. Show that the projection of AB on CD is equal to that of CD on AB. Also find the cosine of their inclinations.

2. a) Find the moment about a line through the origin having direction of $3\boldsymbol{i}+2\boldsymbol{j}+5\boldsymbol{k}$ due to a 20 kg force acting at a point (4, -3, 1) in the direction $2\boldsymbol{i}+4\boldsymbol{j}+6\boldsymbol{k}$

   b) Prove that the area of the triangle formed by joining the midpoint of one side of the non-parallel sides of a trapezium to the extremities of the opposite side is half that of the trapezium.

   c) If **a**, **b**, **c** be the position vectors of A, B, C respectively. Show that $\boldsymbol{a}\times\boldsymbol{b}+\boldsymbol{b}\times\boldsymbol{c}+\boldsymbol{c}\times\boldsymbol{a}$ is perpendicular to the plane ΔABC

3. a) If $[\boldsymbol{abp}]=0$ and $\boldsymbol{a}\times\boldsymbol{b}\neq 0$, express $\boldsymbol{p}$ in terms of $\boldsymbol{a}$ and $\boldsymbol{b}$.

   b) Specify the conditions required to be fulfilled by the vectors **a, b, c** so that [a b c] vanishes.

   c) Solve the vector equation $\boldsymbol{x}+\boldsymbol{x}\times\boldsymbol{a}=\boldsymbol{b}$ for **x** where **a** and **b** are not in the same or opposite direction.

4. a) Specify the conditions required to be fulfilled by the vectors a, b, c so that $\mathbf{a}\times(\mathbf{b}\times\mathbf{c})=(\mathbf{a}\times\mathbf{b})\times\mathbf{c}$.

   b) If $\frac{da}{dt}=\underline{w}\times\underline{a}$ and $\frac{db}{dt}=\underline{w}\times\underline{b}$, then show that $\frac{d}{dt}(\underline{a}\times\underline{b})=\underline{w}\times(\underline{a}\times\underline{b})$.

   c) For the curve $x=3\cos t$, $y=3\sin t$, $z=4t$, find principal normal **N**, and binormal **B**.

B.Sc. Engg. (ME)(3rd Sem) March 05, 2019 (Morning)

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination — Winter Semester, A. Y. 2018-2019
Course No.: MCE 4321 — Time: 1 Hour 30 Min(s)
Course Title: Manufacturing Process — 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.

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1. a) Explain with an example the value adding process by manufacturing and hence state the different production engineering domains with its roles and applications. 10
   b) What are the differences between bulk forming process and metal working processes? Classify the different types of rolling operations and hence explain the necessary diagram the (i) Four high mill rolling, (ii) Ring rolling operations. 15

2 a) Explain with necessary sketches the differences between a wire drawing and tube drawing processes. 10
   b) What is casting processes? Explain with schematic illustration the different steps in sand casting processes. 15

3 a) List the different techniques for producing powder used in Powder metallurgy process and explain briefly with necessary diagram the different types of atomization used for producing metallic powders. 15
   b) Why sintering operation is needed in powder metallurgy process? Explain the typical heat treatment cycle used in sintering and correlate its effects on a microscopic scale with diagram. 10

4. a) What are the differences between thermosetting and thermoplastic? List the different thermosetting and thermoplastic materials with applications? 13
   b) Explain a suitable process with necessary diagram that can be used for making plastics bottles and liquid container. 12

BBA in TM/ 3rd Semester **11 March 2019 (Afternoon)**

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

Mid Semester Examination — Summer Semester, A.Y. 2018-2019
Course Code: MCE 4361 — Time : 1.5 hours
Course Title: Mechanical Technology 1 — Full Marks : 75

There are **4 (four)** Questions. Answer any **Three** Questions. Tables will be supplied.
Marks in the Margin indicate the full marks.

1. a. Define and classify fuels. Give example of each. **11**
   b. Distinguish between bio-fuel and fossil fuel. **7**
   c. Differentiate between fission and fusion. Enlist at least three names of nuclear fuel **7**

2. a. Define thermodynamic system, boundary and surroundings. **9**
   b. Classify thermodynamic systems with example. **9**
   c. Narrate with example (i) Intensive properties and (ii) Extensive properties of fluid **7**

3. a. List the names of thermodynamic processes. **5**
   b. State second law of thermodynamics. What are the limitations of the first law of thermodynamics? **11**
   c. Draw Carnot cycle in *P*-*V* and *T*-**S** plane. Why is Carnot Cycle not used practically? **9**

4. a. Draw a vapor power cycle and show the elements used in this cycle. **5**
   b. Draw modified Carnot cycle and Rankine cycle with super heat and reheat. **9**
   c. Consider a Rankine power cycle as shown. Steam enters the turbine as 100% saturated vapor at 6 MPa and saturated liquid enters the pump at a pressure of 0.01 MPa. If the net power output of the cycle is 50 MW. Determine (i) the thermal efficiency, (ii) the mass flow rate of the system, (iii) the rate of heat transfer into the boiler, (iv) the mass flow rate of the cooling water from the condenser, in kg/s, if the cooling water enters at 20°C and exits at 40°C. **11**

B.Sc. Eng. (EEE) 3rd Semester — 12 March 2019 (Afternoon)

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

Mid Semester Examination — Summer Semester, A.Y. 2018-2019
Course Code: MCE 4391 — Time : 1.5 hours
Course Title: Basic Mechanical Engineering — Full Marks : 75

There are **4 (four)** Questions. Answer any **Three**.
Marks in the Margin indicate the full marks. Programmable calculators are not allowed.

1 a) What is fuel? Write down the requirements of a good fuel? **7**
b) What are the intensive and extensive properties of sytem? What is quasi-equilibrium process? **8**
c) A Carnot heat engine receives 750 kJ of heat from a high-temperature source at 685°C and rejects heat to a low-temperature sink at 35°C. Determine the (i) thermal efficiency of this heat engine and (ii) amount of heat rejected from the sink per cycle. **10**

2 a) What are the boiler mountings and accessories? What are the differences between fire tube and water tube boiler? **7**
b) Why is the Carnot cycle not a practically viable cycle? What are the differences between Otto cycle and Diesel cycle? **7**
c) In a Diesel cycle, the compression ratio is 16. Compression begins at 0.15 MPa, 45°C. The heat added is 1500 MJ/kg. Find (i) the maximum temperature in the cycle, (ii) work doen per kg of air (iii) the cycle efficiency, (d) the temperature at the end of the isentropic expansion, (iv) the cut-off ratio and (v) the MEP of the cycle. **11**

3 a) Draw the schematic of Francis Turbine. Label the important components of it. **8**
b) What is the function of the guide vane of a Francis turbine? **4**
c) Mention the differences between the Francis and Kaplan turbine. **6**
d) In kaptai hydroelecetic dam, there are five turbines (2 x 40 MW and 3 x 50 MW). The average height of the dam is 30 m. The turbines are rotating 150 rpm. Find the specific speed of the turbine. Based on specific speed, comment which types of turbines is running in Kaptai dam. **7**

4 a) What are the differences among fan, blower and compressor? **6**
b) What does a spear valve in Pelton wheel do? With a schematic show how it works. **7**
c) A Pelton turbine rotates at an angular speed of 400rpm, developing 67.5 kW under a head of 60 m of Water. The inlet pipe diameter at the base of the single nozzle is 200 mm. The operating conditions are velocity coefficient, $C_v = 0.97$; speed factor, $\varphi = 0.46$, and efficiency $nT = 0.83$. Determine (i) The volumetric Flow rate, (ii) The diameter of the jet, (iii) the wheel diameter, and (iv) the pressure in the inlet pipe at the nozzle base. **12**

BSc. Eng. (M)/ HDME/ 5th Sem.
BScTE(2 Yr.)/ 1st Sem.

04 March 2019
(Morning)

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

Mid Semester Examination — Winter Semester, A.Y. 2018-2019
Course Code: MCE 4503/MCE 4595 — Time : 1.5 hours
Course Title: Mechanics of Machines — Full Marks : 75

There are **4** Questions. Answer any **3** of them.
Marks in the margin indicate the full marks. Assume reasonable data if necessary.
Programmable calculators are not allowed. Don't write on this question paper.

1 a) With necessary sketches classify *joints.* 8

b) Drawing simplified diagrams, discuss different cases of *Grashof* and *non-Grashof* conditions for a *fourbar pin-jointed mechanism* for a single degree of freedom. 12

c) Derive the *equation* to determine the *degree of Freedom in planar mechanism* 5

2 Design a fourbar linkage to move the object in the Figure.1 (page 3) from position 2 to 3 using points A and B for attachment. Add a driver dyad to limit its motion to the range of positions designed making it a sixbar. All fixed pivots should be on the base. Solve the problem on that figure and attach it with your script. 25

3 a) Figure. 2 shows a power hacksaw, used to cut metal. Link 5 pivots at O_5 and its weight forces the sawblade against the workpiece while the linkage moves the blade (link 4) back and forth within link 5 to cut the part. Determine its *mobility* 15

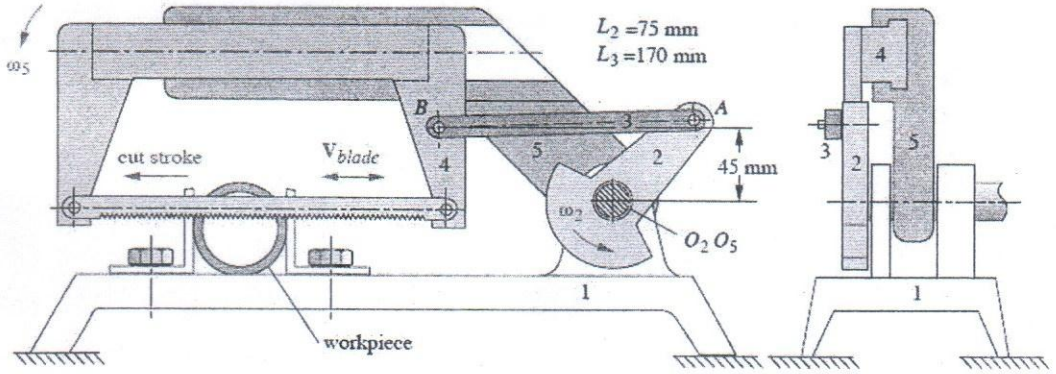


Figure. 2

b) Define *Kinematic chain* and *Mechanism*. Find the *Grashof* condition of the mechanism in Figure. 3 10

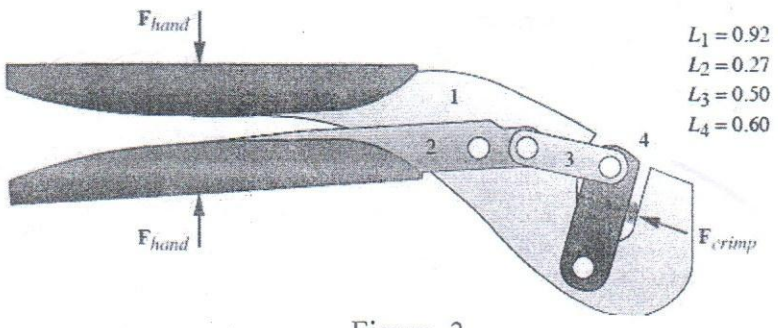


Figure. 3

19

4 a) Forming the *vector loop* equation for a *fourbar linkage* then solve for the unknown angles. 13

b) For the following Figure 4 fourbar linkage with the link lengths L_1=100mm, L_2=40mm, L_3=120mm, L_4=80mm. For θ_2=30° find all possible values of θ_3 and θ_4. 12

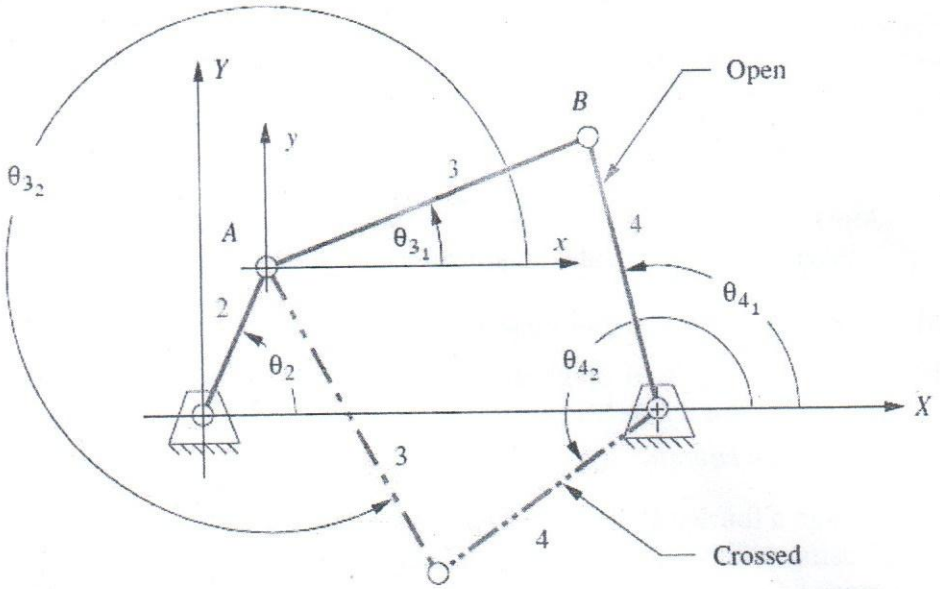


Figure. 4

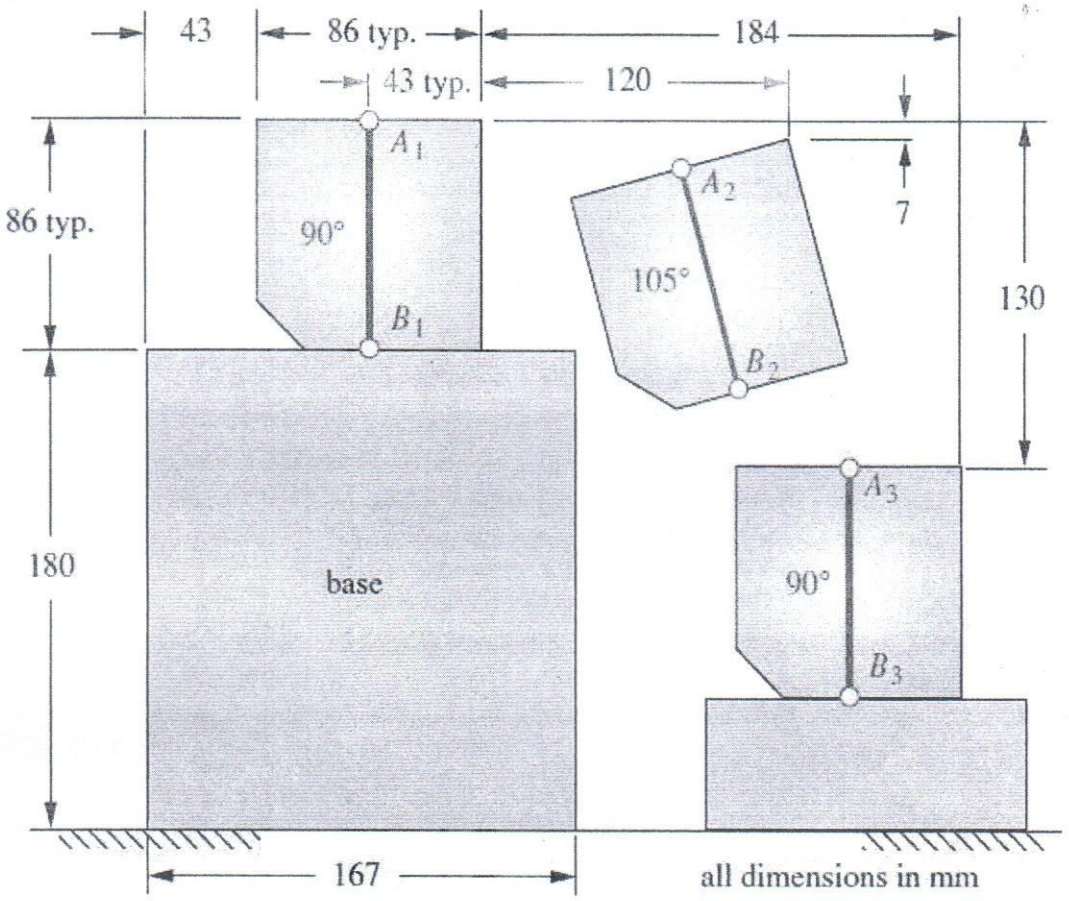

43
86 typ.
184
43 typ.
120
7
86 typ.
A_1
90°
B_1
A_2
105°
B_2
130
180
base
A_3
90°
B_3
167
all dimensions in mm

Figure 1.

B.Sc.Engg. (M)5th Sem./
B.Sc. TE (2 Yr. Prog), 1st Sem.

12 March, 2019 (Morn)

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

Mid- Semester Examination
Course No. MCE 4507/MCE 4593
Course Title: Control and Automation

Winter Semester, A.Y. 2018-2019
TIME : 1.5 Hours
Full Marks : 50

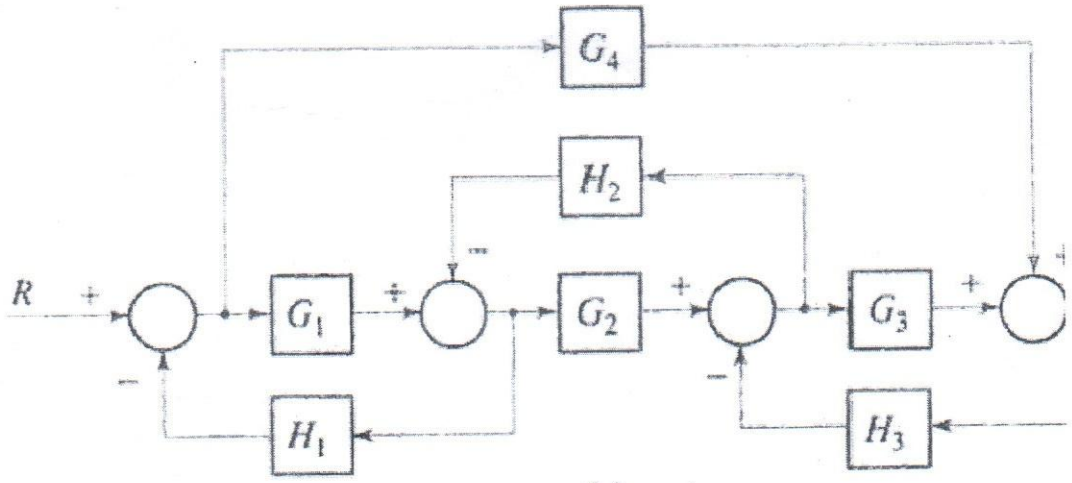
There are 4 (Four) Questions. Answer any 3(Three) Questions.
Marks in the margin indicate full marks.

1. a) Define Industrial Automation. Compare Automation with Control. Describe the major roles of Automation in Industry. 8-2/3
   b) Define economy of scope and economy of scale. Write down the characteristics of different types of Automation. 8

2. a) Describe the various elements of an Industrial Automation Systems and how they are organized hierarchically in levels. 8-2/3
   b) Describe with the help of sketches elements of Industrial Sensors and Instrumental Systems. 8

3. a) Write the sequence of mathematical modeling by using Laplace transformation method. With the help of example of spring mass and damper system explain the method. 8-2/3
   b) With the help of the example of a rotating mass with a rigid shaft explain the characteristics of a first order system. 8

4. a) Explain the automatic control system of a grinding machine with necessary sketches.. 8-2/3
   b) What are the testing signals. Simplify the following block diagram to a single block diagram. 8



(a)

B.Sc. Engg. (ME)/HDME/ 5th Sem. 7 March 2019 (Morning)

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

Mid Semester Examination
Course No Math 4511
Course Title: Statistics and Quality Control

Winter Semester, A. Y. 2018-19
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 and charts are provided at the end of the question.

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1. a) Raw data on the weight of a product collected from a factory is tabled below: [25]

198	147	299	230	215
155	236	267	192	204
213	224	191	210	231
257	193	208	271	244
170	181	226	178	173
218	217	284	158	250
210	260	137	151	205

i. Make the data into appropriate classes and then prepare a frequency table.
ii. Determine the Range, Mean, Median and Mode.
iii. Draw a histogram.

2. a) Unplanned shutdowns have been occurring frequently in a manufacturing plant. After much discussion by the top management and engineers, consensus reached to the points that 'Oil leakage' and 'Cooling failure' as the primary causes. A diagnostic approach based on the fact was introduced. The table below provides data on the causes of previous shutdowns: [15]

Causes	*Frequency*
Oil leakage	55
Human error	16
Cooling failure	15
Initiator System	25
Interlock malfunction	19
Heat Exchanger error	75

Convert the data into a Pareto Table and draw a Pareto Diagram. Then find the vital few and comment about the consensus versus fact.

b) The average life of a certain type of small motor is 10 years with a standard deviation of 2years.The Manufacturer replaces all motors free of charge that fail while under guarantee. If she is willing to replace only 3% of the motors that fail, how long a guarantee should be offered? Assume that the life time of a motor follows a normal distribution. [5]

c) Cars arrive at the drive-up window of a local fast food restaurant at the rate of 5 per minute. What is the probability that no car arrive in a particular minute? What is the probability that more than 3 cars arrive in a particular minute? [5]

3. a) A random sample of 5 hinges is selected from a steady stream of product from a punch press and the proportion nonconforming is 0.15. What is the probability of 1 nonconforming unit in the sample? What is the probability of 2 or less? What is the probability of 2 or more? [8]

   b) In an industrial process, the diameter of a ball bearing is an important measurement. The buyer sets specifications for the diameter to be 3.0 ± 0.01cm.The implication is that no part falling outside these specifications will be accepted. It is known that in the process the diameter of a ball bearing has a normal distribution with mean 3.0 and standard deviation 0.005. On average, what percentages of manufactured ball bearings will be scrapped? [10]

   c) Draw a cause and effect(Ishikawa) diagram for a large no of faulty pumps produced by a pump manufacturing company. [7]

4. a) TP Bolts Ltd. Produces bolts of a certain diameter. From a day's production a sample of 5 pipes is selected randomly from the production line and their diameters (in mm) are recorded. The average diameter and range of this sample (of size 5) are computed and recorded. The Quality Control Engineer collected this type of samples in 10 days in the month of February and the findings are shown in table below. From this table, draw the *X-bar* and *R* chart. After finalizing the control charts, in a given day, five(5) bolts are randomly selected with the diameter(mm) of 10.746, 10.789, 10.01, 9.89, and 10.20. Now using the control charts, comment on it. [15]

Day	Average diameter of the sample(mm)	Range, *R*
1	10.769	0.050
2	10.730	0.016
3	10.718	0.040
4	10.728	0.014
5	10.730	0.029
6	10.720	0.020
7	10.711	0.038
8	10.713	0.026
9	10.718	0.008
10	10.789	0.032

   b) What do you understand by sampling? Describe stratified and cluster sampling methods with examples. [10]

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Control Chart Constants

Sample Size, n	A_2	D_3	D_4
2	1.880	0	3.267
3	1.023	0	2.575
4	0.729	0	2.282
5	0.577	0	2.115
6	0.483	0	2.004

$$UCL = \bar{\bar{x}} + A_2\bar{R}$$
$$LCL = \bar{\bar{x}} - A_2\bar{R}$$
$$UCL = D_4\bar{R}$$
$$LCL = D_3\bar{R}$$

$b(x; n, P) = {}^{n}C_x * P^x * (1 - P)^{n-x}$

$P(x; \mu) = (e^{-\mu})*(\mu^x) / x!$

$h(x; N, n, k) = [\,{}^{k}C_x\,]*[\,{}^{N-k}C_{n-x}\,] / [\,{}^{N}C_n\,]$

Sturg's rule, $i = R / (1 + 3.322 \log n)$

Median

$$M_d = L + \left(\frac{N/2 - n_b}{n_w}\right) i$$

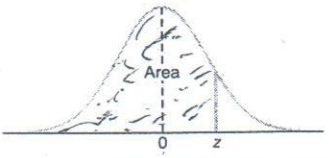

Table A.3 Areas under the Normal Curve

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.4	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003	0.0002
−3.3	0.0005	0.0005	0.0005	0.0004	0.0004	0.0004	0.0004	0.0004	0.0004	0.0003
−3.2	0.0007	0.0007	0.0006	0.0006	0.0006	0.0006	0.0006	0.0005	0.0005	0.0005
−3.1	0.0010	0.0009	0.0009	0.0009	0.0008	0.0008	0.0008	0.0008	0.0007	0.0007
−3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
−2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
−2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
−2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
−2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
−2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
−2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
−2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
−2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
−2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
−2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
−1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
−1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
−1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
−1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
−1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
−1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
−1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
−1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
−1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
−1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
−0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
−0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
−0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
−0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
−0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
−0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
−0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
−0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
−0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
−0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

Table A.3 (continued) Areas under the Normal Curve

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998

B.Sc Engg.(M)/5th Sem
B.ScTE/1st Sem (2Yr)

05 March, 2019 (Morning)

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

Mid Semester Examination
Course No. MCE 4511/MCE 4591
Course Title: Fluid Machinery

Winter Semester: A.Y. 2018-2019
TIME: 1 hour and 30 minutes
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. Thermodynamic property data are given on separate pages with the question. Assume reasonable values for any missing data. Programmable calculators are not allowed.

1. a) With the help of *h-s* diagram, express the *Isentropic Total-to-Total Efficiency* equations for a turbine and a compressor. [06]
   b) Considering first order approximation on wind turbine performance, which force component on a wind turbine blade is responsible for producing mechanical power on the shaft? Develop the expression for the power being produced. Draw the velocity diagrams if necessary. [09]
   c) Having the knowledge about the cascade view of an *axial flow* turbomachine, what are the fundamental differences one has to encounter when he wants to draw cascade views of a radial turbomachine? [03]
   d) The flow at exit from a turbine stator row has a velocity of *110 m/s* at an angle (α_2) of 65^0 to the axial direction. Calculate the tangential and axial velocity components. The rotor row is moving with a velocity of *55 m/s*. Calculate the velocity magnitude relative to the rotor blades at inlet and the relative inlet flow angle (β_2). At exit from the rotor row the relative flow angle (β_3) is -55^0. Assuming that the axial velocity is constant across the row, what is the absolute exit velocity magnitude and direction? [07]

2. a) For conservation of mass in an axial flow turbine, how do you express the cross-sectional area? Derive with the help of a neat diagram. [05]
   b) For machines operating at constant density and constant radial velocity, show that *the blade height falls as the radius increases*. [06]
   c) Reason the following: "*Over a blade row rothalpy is constant, but not over a stage*". [06]
   d) An axial compressor has a rotor blade row where the inlet velocity is 155 m/s and is in the axial direction. The blade speed is 175 m/s and the relative outlet angle is -40^0 to the axial. The axial velocity is constant across the row. These rotor blades are followed by a set of stator blades to form a complete stage. The stators turn the flow back to the axial direction and the axial velocity is constant across the whole stage. If the total-to-total efficiency is 90%, calculate the total pressure at outlet from the stage and the reaction of the stage. Assume air properties with inlet stagnation conditions of 20^0 C and 1.0 bar. [08]

3. a) Using two alternative approaches, develop *Euler Turbomachinery equation.* [12]
   b) Write down the expressions for important dimensionless coefficients for axial machines. [06]

c) Consider an axial compressor rotor blade row. The inlet velocity is 125 m/s and is in the axial direction. The blade speed is 170 m/s and the relative outlet angle is -40^0 to the axial. The axial velocity is constant across the row. Calculate the relative flow angle at inlet and the absolute swirl velocity at exit and the absolute flow angle. Calculate also the specific work output. [07]

4. a) Upon drawing the meridional view, derive the velocity triangles for a turbomachine where the flow is turned from axial to radial and the blades operate in both the axial tangential and the radial tangential plane. [10]

b) Justify the following: "*The level of reaction in the turbine can be controlled by altering the blade angles and blade height through the machine*". [05]

c) An industrial turbine operates at an 9.2:1 pressure ratio and a mass flow of 83 kg/s using air as the working fluid. The exhaust temperature is 47^0C at and the inlet temperature to the machine is around 1020^0C. The mean blade radius is 0.38 m. The machine is to be designed for a constant axial velocity of 195 m/s. Estimate the blade heights at entry and exit of the turbine. Draw the corresponding meridional view. [10]

B.Sc. Engg. (M)/5th Sem. (Prod.) Date: 11 March 2019 (Morn./Aftern.)
No. of Students: ....

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

THE ORGANIZATION OF THE ISLAMIC CONFERENCE (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

MID SEMESTER EXAMINATION WINTER SEMESTER: 2018-2019
COURSE NO. MCE 4521 TIME: 1 ½ HRS
COURSE TITLE: Materials Engineering FULL MARKS: 75

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

1. (a) Draw the iron and iron carbide thermal equilibrium diagram labelling all points, lines and phase fields. Define ferrite and pearlite. (17)

   (b) Describe the microstructural changes that occur in a high carbon steel containing 1% carbon during slow cooling from austenite range. (08)

2. (a) "Normalized mild steel shows finer grain size than annealed mild steel." Explain in detail how the grain size becomes finer in normalized steel. (12)

   (b) Draw the microstructure of a full annealed file steel. Is this structure desireable? Give reasons for your answer. (10)

   (c) Suggest a suitable annealing heat treatment process for the file steel. (03)

3. (a) Distinguish between austenite and martensite. Mention the important chracteristics of martensite transformation. (10)

   (b) Draw the I.T. diagram for a hypoeutectoid steel and label the diagram completely. Show the cooling curve superimposed on the I.T. diagram to produce a microstructure consisting of:
   (i) Ferrite+Pearlite, (ii) Martensite, (iii) Bainite, (iv) Ferrite+Pearlite + Bainite + Martensite and (v) Bainite + Martensite. (15)

4. (a) What is austempering? What are the advantages and limitation of austempering as compared to conventional quench and temper method? (10)

   (b) Describe the effect of tempering temperature on the hardness, toughness, and microstructure of a quenched high carbon steel part. (15)

B.Sc. Eng. (EEE/HDEE) 5th Semester 12 March 2019 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

THE ORGANISATION OF THE ISLAMIC CONFERENCE (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination — Summer Semester, A.Y. 2018-2019
Course Code: Hum 4521 — Time : 1.5 hours
Course Title: Engineering Management — Full Marks : 75

There are **4 (four)** Questions. Answer any 3 **(Three)** of them.
Marks in the Margin indicate the full marks. Programmable calculators are not allowed.

1 a) A manager of the Carpet city outlet needs to be able to forecast accurately the demand for Soft Shag carpet (its biggest seller). If the manager does not order enough carpet from the carpet mill, customers will buy their carpets from one of the Carpet city's many competitors. The manager has collected the following demand data for the past months. 12

Month	Demand for Soft Shag Carpet (1000 Yd)
1	8
2	12
3	7
4	9
5	15
6	11
7	10
8	12

i) Compute a 3 period weighted moving average forecast for month 4 to 9. Assign 2.5 times more weight for the most recent data compare to the third recent data and 1.5 times more weight for the second recent data compare to the third recent data.

ii) Compute MAD, MSE and RMSE for the period 4 to 8.

iii) Find the production plan for 9th month considering the MAD value.

b) In which cases do you need qualitative forecasting? Explain different types of qualitative forecasting in detail. 6

c) A computer software firm has experienced the following demand for its "Personal Finance" software package in the previous year (2018) 7

Month 2018	Unit
January	56
February	61
March	55
April	70
May	66

Develop a regression analysis to forecast the demand and find the forecast for the month of April, 2019 (this year).

2 a) A firm can produce three types of cloth, say A, B and C. Three kinds of wool are required for it, say, red wool, green wool and blue wool. One unit length of Type A cloth needs 2 yards of red wool and 3 yards of blue wool; one unit length of type B cloth needs 3 yards of red wool, 2 yards of green wool and 2 yards of blue wool; and one unit length of type C cloth needs 5 yards of green wool and 4 yards of blue wool. The firm has a stock of only 8 yards of red wool, 10 yards of green wool and 15 yards of blue wool. It is assumed that the income obtained from one unit length of type A cloth is Tk. 3, of type B Tk. 5 and that of type C cloth is Tk. 4. Formulate the problem as linear programming problem. **6**

b) Objective function: **14**

$$\text{Maximize } Z = 4x + 5y$$

Constrains:

$$2x + y = 6$$
$$x + 2y = 5$$
$$x - 2y = 2$$
$$-x + y = 2$$
$$x + y = 1$$
$$x, y = 0$$

i) Find the feasible area by Graphical Method
ii) Find the optimum value of x and y.
Iii) Find maximum profit
iv) Find range of optimality for x and y

c) Discuss the effect of inaccurate forecasting in any business organization. **5**

3 a) What are the six management theories? Brifely describe them considering the engineering management systems in a modern society. **15**

b) What are the basic organizational structures? How do you specifically illustrate the common management structure? **10**

4 a) What are the functions of engineering management? Brifely describe them considering the engineering management systems in a modern society. **15**

b) What are the types of organizational objectives in a modern shoe industries? Brifely describe the four basic steps for the job instruction training. **10**

B.Sc.TE (2-Yr), 1st Sem.
B.Sc. Engg.(EE)/ HDEE, 5th Sem. Date: March 04, 2019 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination — Winter Semester, A. Y. 2018-2019
Course No.: EEE 4523 / EEE 4595 — Time: 90 Minutes
Course Title: Switchgear and Protection Equipment -I — 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. Symbols preserve their usual meanings.

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1. a) What do you mean by a protective relay? Write the functions of protective relay. How is a protective relay different from a Circuit Breaker? 8

   b) "Dead zone cannot be present in a typical power system", explain this statement using proper diagram. Explain different methods of backup protection. 9

   c) Differentiate between Current Transformer (C.T.) and Potential Transformer (P.T.). Why should secondary of C.T. not be kept open circuited? 8

2. a) Explain ratio error and phase angle error with proper equation. A C.T. has a single turn primary and 400 secondary turns. The magnetizing current is 90 A while the actual primary current is 2078 A. Secondary circuit phase angle is 28°. Calculate the core loss current, actual ratio and ratio error when the secondary carries 5A current. 12

   b) Explain resistance switching with proper diagram. Write down the conditions of resistance switching for different types of oscillation. 13

3. a) What do you understand by ratings of a circuit breaker? Explain different ratings of a circuit breaker. 15

   b) A three phase alternator has the line voltage of 11 kV. The generator is connected to a circuit breaker. The inductive reactance of the circuit breaker is 5 ohm per phase. The distributed capacitance of the circuit breaker between phase and neutral is 0.01 μF. Determine the following : (i) peak restriking voltage across the circuit breaker (ii) frequency of restriking voltage transient (iii) average rate of restriking voltage transient (iv) maximum rate of rise of recovery voltage. Neglect first pole to clear factor. 10

4. a) What do you mean by arc extinction? What are the methods of arc extinction? Explain in details how ionization of gas occurs in the circuit breakers. 10

   b) Explain the working principle of air-blast circuit breaker. What are the problems of conventional air-blast circuit breaker? Explain the mechanism of modifying the conventional structure. 15

B.Sc. Eng. (CSE)/ 5th Sem. **07 March, 2019 (Afternoon)**

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination — Winter Semester: 2018-2019

COURSE NO. : Math-4541 — TIME : 1½ Hours

COURSE TITLE: Multivariable Calculus and Complex Variables — FULL MARKS: 75

There are **4 (Four)** questions. Answer any **3 (Three)** of them. Programmable calculators are not allowed. Do not write anything on this question paper. The figures in the right margin indicate full marks. The Symbols have their usual meaning.

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1. a) (i) Explain how the complex function e^z and the real function e^x are different. How are they similar? **13**

(ii) Show that the Cauchy-Riemann equations hold for the functions u, v given by $u(x,y) = x^3 - 3xy^2$, $v(x,y) = 3x^2y - y^3$. Show that u, v are the real and imaginary parts of a holomorphic function $f : C \to C$.

b) (i) Define a harmonic function and conjugate harmonic function. **12**

(ii) Show that $u(x, y) = xy^3 - x^3y$ is a harmonic function, and find a conjugate harmonic function $v(x, y)$.

2. a) (i) Find the zeros of the following functions $1 + e^z$ and $1 + i - e^z$ **8**

(ii) State whether the following series converge or diverge. Justify your answers.

$$\sum_{n=1}^{\infty} (1+i)^n \text{ and } \sum_{n=1}^{\infty} \frac{1+in(-1)^n}{n^2}$$ **8**

b) Find the radii of convergence of the following power series: **9**

$$(i)\ \sum_{n=1}^{\infty} \frac{2^n z^n}{n} \quad (ii)\ \sum_{n=1}^{\infty} n! z^n \quad (iii)\ \sum_{n=1}^{\infty} n^p z^n \ (p \in N)$$

3. a) State and verify Cauchy Integral Theorem by integrating e^{iz} along the boundary of the triangle with the vertices at the points $1+i$, $-1+i$ *and* $-1-i$. **13**

b) (i) State the Cauchy's integral formula. **12**

(ii) Evaluate, using Cauchy's integral formula,

$\int_c \frac{z^2 - 2z}{(z+1)^2(z^2+4)} dz$, where c is the circle $|z| = 10$.

4. a) Transform the rectangular region ABCD in z-plane bounded by $x = 1$, $x = 3$; $y = 0$ and $y = 3$. Under the transformation $w = z + (2 + i)$. **13**

b) Consider the transformation $w = ze^{i\pi/4}$ and determine the region R′ in w-plane corresponding to the triangular region R bounded by the lines $x = 0$, $y = 0$ and $x + y = 1$ z-plane. **12**

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B.Sc. Engg. (M)/5th Sem
HDME/ 5th Sem

March 08, 2019 (Morning)

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination
Course No.: MCE 4547
Course Title: Principles of CAD/CAM/CAE

Winter Semester, A. Y. 2018-2019
Time: 1 Hours 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.

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1. a) What is CAD, CAE, and CAM? Draw a flow diagram of design processes involved in a product cycle and describes its different steps. 15
   b) What is PDM? Draw the networking structure of design and manufacturing process for PDM. 10

2. a) There are two coordinate systems $X_1Y_1Z_1$ and $X_2Y_2Z_2$, where Z_2 is opposite of Y_1, X_2 is parallel with Z_1, and Y_2 is opposite of X_1. The origin O_2 when measured in $X_1Y_1Z_1$ is (4, 5, 6). The $X_1Y_1Z_1$ coordinates of point P is (1, 2, 3). 15
      (i) With respect to $X_1Y_1Z_1$, using the standard ***Rot(x,θ)***, ***Rot(y,θ)***, ***Rot(z,θ)*** and ***Trans(a,b,c)*** to derive the transformation T^* that will transform the rigid body of $X_2Y_2Z_2$ to coincide with $X_1Y_1Z_1$.
      (ii) Calculate $P^* = T^* \circ [1\ 2\ 3\ 1]^T$.
      (iii) Is T^* the $T_{1\to2}$ or $T_{2\to1}$?
   b) What do you mean by graphical program? What are the disadvantages of a graphics program written directly with the device driver commands? 10

3. a) During building the Oct-tree representation of a solid, when deciding the color of an octant (i.e., whether it is inside, outside, or intersecting the boundary of the object), you cannot simply decide it by merely looking at the center point of the octant, why? Then, how do you compute the Oct-tree representation? What is the major disadvantage of it? 15
   b) Describe the following modeling functions with figures: 10
      i) Primitive creation
      ii) Boolean operation
      iii) Sweeping
      iv) Skinning
      v) Rounding

4. a) Derive a general expression of a Hermit curve for two 3D points $\mathbf{P_0}$, $\mathbf{P_1}$ and their respective tangent vectors $\mathbf{P_0'}$ and $\mathbf{P_1'}$. What is the main benefit of using a Hermit curve? 15
   b) Write down the properties and drawbacks of Bezier Curve. 10

BSc. Engg. (M) 5th Sem/DTE 1st Sem

11 March 2019

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

MID SEMESTER EXAMINATION
Course No: MCE-4551
Course Name: Refrigeration

Winter Semester: 2018-2019
TIME : $1^1/_2$ HRS
FULL MARKS: 75

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

1. a) Define Ton of Refrigeration (**TR**). Convert **1 TR** to equivalent BTU. Write some applications of Refrigeration system. Establish a relation between COP of the heat pump and refrigeration system operates on a reversed Carnot cycle. (10)

   b) An engine receives heat (Q_4) from a temperature source of **200°C** and rejects heat (Q_3) to a sink of **40°C**. A refrigerating compressor receives **60%** of the work (W) produced by the engine. The refrigeration cycle absorbs heat (Q_1) from a **-20°C** source and reject heat (Q_2) to **40°C** sink. Calculate (15)
   i. The work done by the compressor
   ii. Heat quantities (Q_4 & Q_3) for the engine.
   iii. Heat quantities (Q_1 & Q_2) for the refrigerator.
   Draw the system diagram.

2. a) With appropriate diagrams explain different steps of transformations from ideal vapor compression cycle to actual cycle. (10)

   b) An actual refrigerator operates on the vapor compression refrigeration cycle with **refrigerant-22** as the working fluid. The refrigerant evaporates at **-15°C** and condenses at **40°C.** The isentropic efficiency of the compressor is **83%**. The refrigerant is superheated by **5 °C** at the compressor inlet and sub cooled by **5 °C** at the exit of the condenser. Determine (*a*) the heat removed from the cooled space and the work input, in kJ/kg and the COP of the cycle. Determine (*b*) the same parameters if the cycle operated on the ideal vapor-compression refrigeration cycle between the same evaporating and condensing temperatures. Draw cycles on P-h diagrams. (15)

3. a) What is a pure substance? Explain phase change processes of a pure substance. (10)

   b) A heat pump with **refrigerant-134a** as the working fluid is used to keep a space at **25°C** by absorbing heat from geothermal water that enters the evaporator at **50°C** at a rate of **0.065 kg/s** and leaves at **40°C**. The refrigerant enters the evaporator at **20°C** with a quality of **23%** and leaves at the inlet pressure as saturated vapor. The refrigerant loses **300 W** of heat to the surroundings as it flows through the compressor and the refrigerant leaves the compressor at **1.4 MPa** at the same entropy as the inlet. Determine – (15)
   (i) the degrees of subcooling of the refrigerant in the condenser,
   (ii) the mass flow rate of the refrigerant,
   (iii) the heating load and the COP of the heat pump, and

(iv) the theoretical minimum power input to the compressor for the same heating load.

4. a) Show that the power consumptions increases for a VCR cycle with sub-cooling of liquid refrigerant by vapour refrigerant. (10)

b) A 4-cylinder reciprocating compressor operating on **Refrigent-22**, is used in a plant for a cold storage. The compressor runs at **1500 rpm**. The cooling capacity required is **30 TR**. The evaporating temperature is **-10^0C** and the condensing temperature is **45^0C**. The liquid is sub-cooled in the condenser by **10^0C** and vapor is superheated in the evaporator to **5^0C**. The compressor cylinder clearance is **6%** and isentropic efficiency is **80%**. Cooling water enters the condenser at **20^0C** and leaves at **35^0C**. Compute the following- (15)

(i) The clearance volumetric efficiency. Assume an index of **1.2** for re-expansion of clearance vapor.

(ii) Bore and stroke of compressor cylinder, if the total volumetric efficiency is **75%**. Assume a stroke is **1.5** times the bore.

(iii) Isentropic and actual work of compression, **kW.**

(iv) Isentropic and actual discharge temperature, **^{o}C.**

(v) Heat rejected in the condenser, kW and mass flow rate of water needed, **Kg/h.**

(vi) **COP** of the cycle.

Draw cycle on P-h diagram.

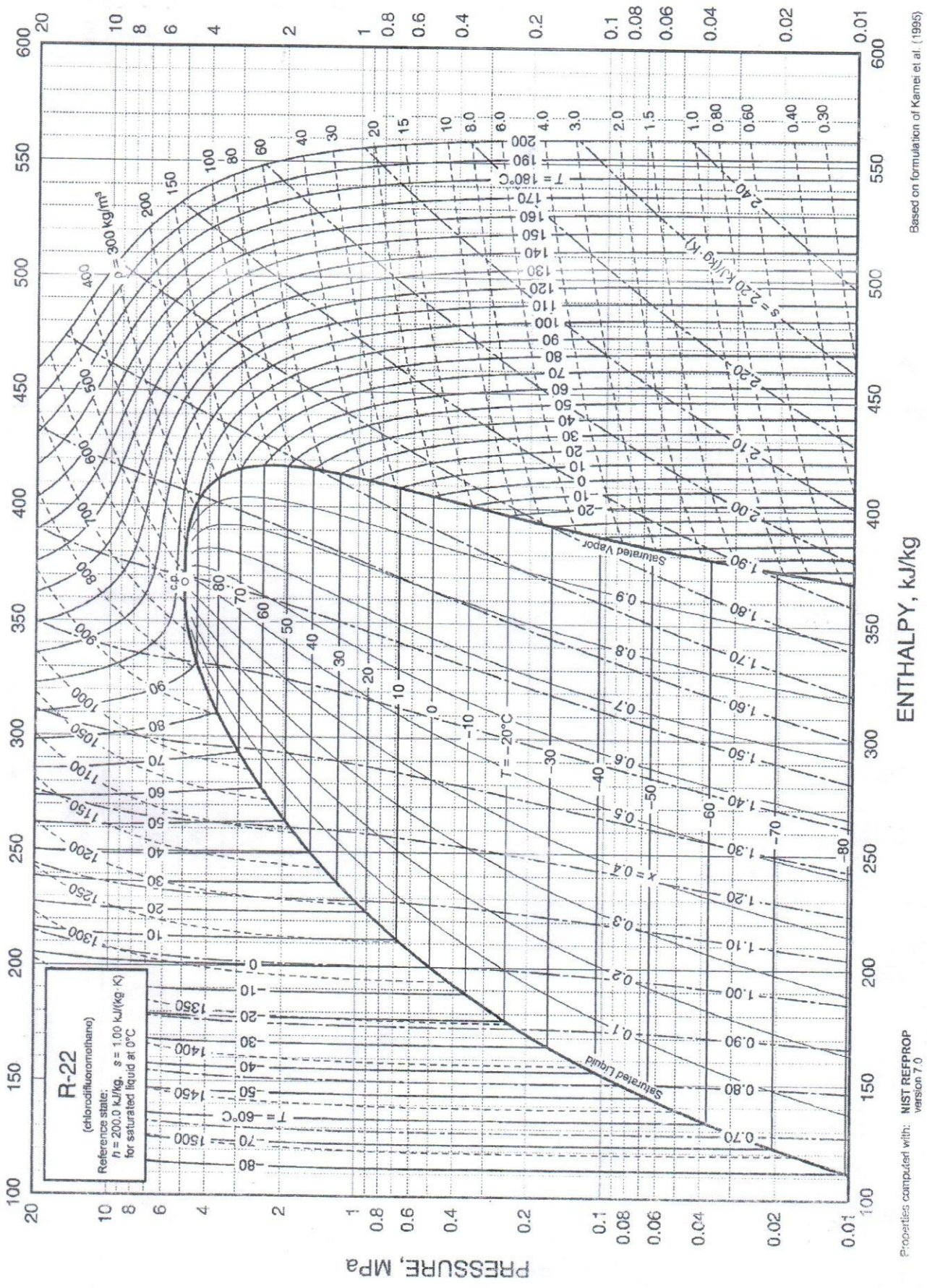

Fig. 2 Pressure-Enthalpy Diagram for Refrigerant 22

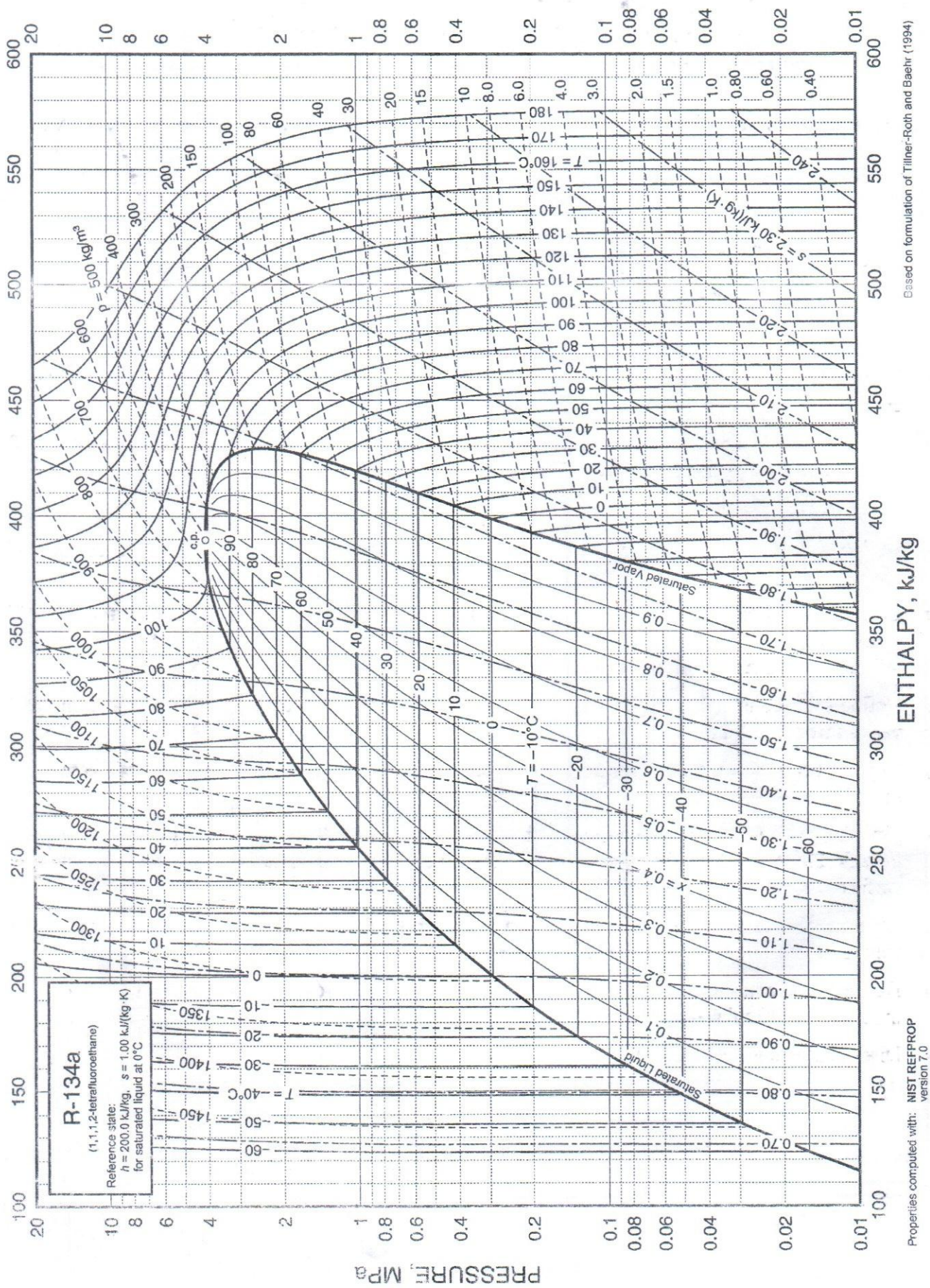

Fig. 8 Pressure-Enthalpy Diagram for Refrigerant 134a

BSc.ME/ HDME (5th Sem)/ DTE (1st Sem) 08 March 2019 (Morning)

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

Mid Semester Examination
Course Code: **MCE 4573**
Course Title: **Renewable Energy Resources**

Winter Semester : **A.Y. 2018-2019**
Time : **1.5 Hours**
Full Marks : **75**

There are 04 (four) Questions. Answer any 03 (three) of them.
Figures in the margin indicate the full marks. Assume reasonable data if necessary.
The symbols have their usual meaning. Do not write on the Question Paper.

1	a)	What are the renewable energy resources? Discuss the advantages of using renewable energy sources over conventional energy sources.	9
	b)	Based on the geographical location of your country, which renewable energy resource has most potential for generating power? Explain in details why.	8
	c)	Write short notes on hydropower and geothermal energy.	8
2	a)	Define solar altitude angle, zenith angle and solar azimuth angle. Draw neat sketches to represent these angles.	10
	b)	Calculate solar altitude angle, solar azimuth angle, zenith angle, profile angle and time of sunrise for a 45° sloped surface facing 25° west of south at 16:30 solar time on April 1 at a latitude of 52°, Also find the time of sunrise and sunset on the surface.	15
3	a)	Define solar constant and extra-terrestrial radiation. Explain why extra-terrestrial radiation varies throughout the year.	8
	b)	Explain beam and diffuse radiation with sketches, Write an expression for ratio of beam radiation.	7
	c)	Find the day's total solar radiation on a horizontal surface in the absence of atmosphere, at latitude 23° N on May 05. Also calculate the amount of solar radiation received on that surface between the hours 9 AM to 3 PM.	10
4	a)	What are the basic methods for solar energy conversion? Describe working principle of a solar photovoltaic system with neat sketches.	8
	b)	Explain the construction and working principle of a device which can be used for measuring total solar radiation on any surface.	10
	c)	Discuss attenuation of solar radiation with sketches.	7

Equations

$$\delta = 23.45 \sin\left(360\frac{284+n}{365}\right)$$

$$\begin{aligned}\cos\theta = {} & \sin\delta\sin\phi\cos\beta - \sin\delta\cos\phi\sin\beta\cos\gamma \\ & + \cos\delta\cos\phi\cos\beta\cos\omega + \cos\delta\sin\phi\sin\beta\cos\gamma\cos\omega \\ & + \cos\delta\sin\beta\sin\gamma\sin\omega\end{aligned}$$

$$\cos\theta_z = \cos\phi\cos\delta\cos\omega + \sin\phi\sin\delta$$

$$\gamma_S = \text{sign}(\omega)\left|\cos^{-1}\left(\frac{\cos\theta_z\sin\phi - \sin\delta}{\sin\theta_z\cos\phi}\right)\right|$$

$$\cos\omega_s = -\frac{\sin\phi\sin\delta}{\cos\phi\cos\delta} = -\tan\phi\tan\delta$$

$$\tan\alpha_p = \frac{\tan\alpha_s}{\cos(\gamma_s - \gamma)}$$

$$\begin{aligned}H_o = {} & \frac{24\times 3600 G_{sc}}{\pi}\left(1 + 0.033\cos\frac{360n}{365}\right) \\ & \times\left(\cos\phi\cos\delta\sin\omega_s + \frac{\pi\omega_s}{180}\sin\phi\sin\delta\right)\end{aligned}$$

HDME/5th Sem March 08, 2019 (Morning)

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination
Course No.: MCE 4585
Course Title: Automotive Technology-I

Winter Semester, A. Y. 2018-2019
Time: 1 Hours 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.

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1. a) What is an engine? Write down the classifications of engine. Describe the working principle of a 2-stroke engine with necessary figures. 15

   b) Describe the differences between a petrol engine and a diesel engine. 10

2. a) What is a carburetor? Describe the requirements of a carburetor in an automotive vehicle. 10

   b) Explain the actual valve timing diagram and valve indicator diagram of a 4-stroke petrol engine. 15

3. a) Explain the operating procedure of the mechanical fuel pump with necessary diagram. 12

   b) What is an EFI system? Explain the operational procedure of an EFI system with a block diagram. 13

4. a) Why cooling system is necessary in an automotive? Describe the operation of automotive water cooling system with a simple diagram. 13

   b) Explain the carburetor operation while an automotive is on the idle state and on the starting state. 12

HDME 5th Sem March11, 2019 (Morning)

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination
Course No.: MCE 4587
Course Title: Automobile Maintenance Engineering (I)

Winter Semester, A. Y. 2018-2019
Time: 1 Hours 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.

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1. a) Briefly classify the types of maintenance with adequate comparative explanation. (8)

   b) What are the causes for crack appearance in engine metal parts? Briefly explain crack detection methods and its rectification process. (17)

2. a) Provide explanation for various types of contaminants which are hazardous for engine performance and overall efficiency. (10)

   b) How the measurement and fitting of valve spring is done while carrying out the engine maintenance? Provide all the necessary steps. (15)

3. a) Explain the maintenance/serviceprocedure of an engine oil pump. (8)

   b) Write all the necessary methods for cleaning out engine parts. Explain. (17)

4. a) Why engine cylinder deglazing is required and how it is carried out? Explain. (6)

   b) Write the maintenance steps for engine valves, valve seats retainers, valve rotators, and keepers. Briefly explain. (6)

   c) How the inspection and rebuilding of crankshaft is carried out. Provide detailed explanation. (13)

B.Sc.Engg. (M)/7th Sem /B.Sc.TE(2 Yr-Prog)/4th Sem/B.Sc.TE(1 Yr-Prog.)/2nd Sem

March 11, 2019 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

MID SEMESTER EXAMINATION

MCE 4703 Vibration & System Dynamics

WINTER SEMESTER: 2018-2019

TIME : 1.5 Hrs

FULL MARKS : 75

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

1. A simple pendulum is pivoted at point O as shown in Fig. 1. If the mass of the rod is negligible and a periodic excitation $X_0 = a\sin(\omega t)$ is applied to the spring base,

   i) Derive the equation of motion and determine the natural frequency of the system. (8)

   ii) Derive the complementary solution from the equation of motion and show how this response dies out with time. Determine also the damped natural frequency. (9)

   iii) Discuss on the over damping, critical damping and underdamping conditions from the above solution. (3)

   iv) Determine the steady state response for the external excitation. (5)

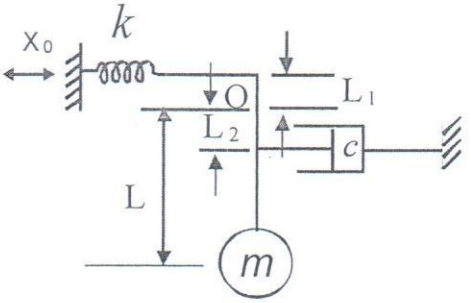


Fig. 1

2. (a) The cord can be assumed inextensible in the spring-mass-pulley system shown in Fig.2. Determine the natural frequency of vibration if the mass m is displaced slightly and released. Use the energy method. (12)

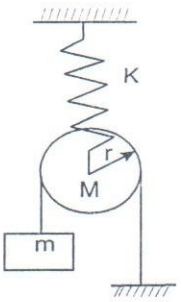


Fig. 2

(b) The rigid weightless rod is restrained to oscillate in a vertical plane shown in Fig. 3. Derive the equation of motion and determine the natural frequency of the system for the small oscillation of mass m. (13)

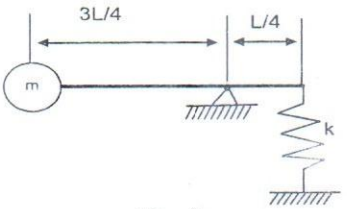


Fig. 3

3. (a) Derive the equations of motion using Lagrange's equation for the system shown in Fig. 4. (10)

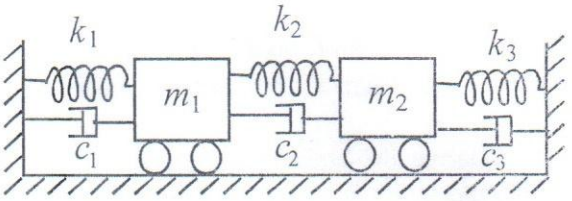


Fig. 4

(b) A schematic representation of an automobile is shown in Fig.5. If the automobile weighs 4000 lb, and has a radius of gyration about the center of gravity of 4.5 ft, derive the equations of motion for free vibration. Determine also the natural frequencies of the system and amplitude ratios. The combined front spring k_1 is 250 lb/in and k_2 is 270 lb/in. (15)

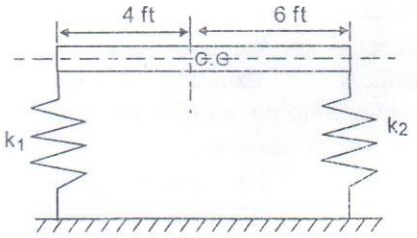


Fig. 5

4. A motor generator set consists of two armatures P and R with a flywheel between them at Q. The diameter of the shaft between P and Q is 120 mm and between Q and R is 90 mm. The length of the shaft between P and Q is 350 mm and between Q and R is 250 mm. The mass of the rotor P is 450 kg and its radius of gyration is 250 mm. The mass of the rotor Q is 540 kg and its radius of gyration is 300 mm. The mass of the rotor R is 360 kg. The modulus of rigidity of the material of the shaft is 84 GPa. The system can vibrate with one node at 106.5 mm from P, the flywheel Q being at antinode. Using the data of rotors given below, determine: i) the position of the other node, ii) the natural frequency of the free torsional vibrations, for the given positions of the nodes, and iii) the radius of gyration of the rotor R. (25)

B.Sc Engg.(M)/8th Sem 04 March, 2019 (Afternoon)

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

Mid Semester Examination
Course No. MCE 4705
Course Title: Applied Thermodynamics

Winter Semester: A.Y. 2018-2019
TIME: 1 hour and 30 minutes
Full Marks: 75

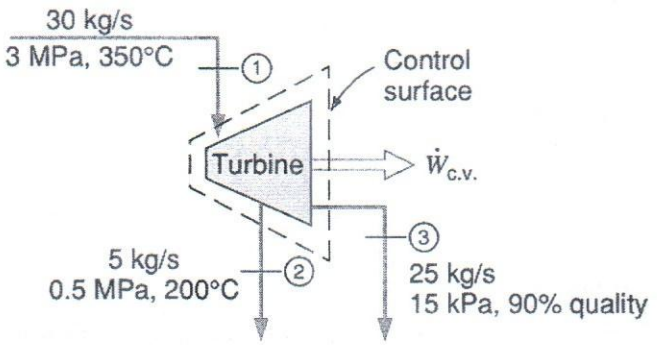
There are 4 (Four) Questions. Answer any 3 (Three) Questions.

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

1. a) Show that "*The equality in the Clausius inequality holds for totally or just internally reversible cycles and the inequality for the irreversible ones.*" [08]
   b) Which properties of a system have been defined as consequences of the thermodynamic laws? Discuss briefly. [08]
   c) Develop the *steady flow energy equation* for a single stream device. [05]
   d) With the help of schematic diagrams, explain *Flow work.* [04]

2. a) Develop the *Tds* relationships where *entropy* changes of a system are related to the changes in other properties. [05]
   b) Explain *internally, externally and totally reversible processes.* [06]
   c) Steam enters an adiabatic turbine at 5 MPa, 650^{0}C, and 80 m/s and leaves at 50 kPa, 150^{0}C, and 140 m/s. If the power output of the turbine is 8 MW, determine (a) the mass flow rate of the steam flowing through the turbine and (b) the isentropic efficiency of the turbine. [09]
   d) The radiator of a steam heating system has a volume of 20 L and is filled with superheated water vapor at 200 kPa and 150^{0}C. At this moment both the inlet and the exit valves to the radiator are closed. After a while the temperature of the steam drops to 40^{0}C as a result of heat transfer to the room air. Determine the entropy change of the steam during this process. [05]

3. a) Discuss the mechanisms for energy transfer to or from a system. Write down the energy balance corresponding to the energy transfer for an *adiabatic system.* [05]
   b) With an example, reason why 1st law efficiency is not a realistic measure of performance but 2nd law efficiency is. [05]
   c) Write down the fundamental characteristics of a *heat engine*. [03]
   d) An insulated steam turbine receives 30 kg of steam per second at 3 MPa, 350^{0}C. At the point in the turbine where the pressure is 0.5 MPa, steam is bled off for processing equipment at the rate of 5 kg/s. The temperature of this steam is 200^{0}C. The balance of the steam leaves the turbine at 15 kPa, 90% quality. Determine the exergy per kilogram of the steam entering and at both points at which steam leaves the turbine, the isentropic efficiency and the second-law efficiency for this process. [12]



4. a) Develop the expression for *Stream exergy change (on a unit mass basis)* during a process. [12]

   b) Show that "*The exergy of an isolated system during a process always decreases or, in the limiting case of a reversible process, remains constant*". [06]

   c) Consider an air compressor that receives ambient air at 100 kPa and 25^{0}C. It compresses the air to a pressure of 1 MPa, where it exits at a temperature of 540K. Since the air and compressor housing are hotter than the ambient surroundings, 50 kJ per kilogram air flowing through the compressor are lost. Find the reversible work and the irreversibility in the process. [07]

B.Sc.Engg. (M)7th Sem./B.Sc. TE(1 Yr. Prog.),1st Sem./ 07 March, 2019
B.Sc. TE (2 Yr. Prog), 3rd Sem. Afternoon

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

Mid-term Examination
Course No. MCE 4709/MCE 4797
Course Title: Machine Design - II

Winter Semester A.Y. 2018-2019
Time : 1.5 Hours
Full Marks : 50

There are 4 (Four) Questions. Answer any 3(Three) Questions.
Marks in the margin indicate full marks. Tables and graphs along with some important formula are attached. Assume reasonable value for missing data.

1. A 75 kW induction motor runs at 740 rpm in clock wise direction as shown in Fig.1. A 19 tooth helical pinion with 20° normal pressure angle, 10 mm normal module and a helix angle of 23° is keyed to the motor shaft. Draw a 3-dimensional sketch of the motor shaft and the pinion. Show the forces acting on the pinion and the bearing at A and B. The thrust should be taken out at A. (16-2/3)

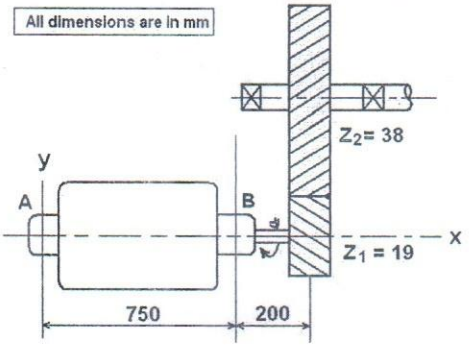


Fig. 1

2. In a conveyor system a step-down gear drive is used. The input pinion is made of 18 teeth, 2.5 mm module, 20° full depth teeth of hardness 340 Bhn and runs at 1720 rpm. The driven gear is of hardness 280 Bhn and runs with moderate shock at 860 rpm. Face width of wheels is 35 mm. The gears are supported on less rigid mountings, less accurate gears and contact across full face may be assumed. The ultimate tensile strength of pinion and gear materials is 420 and 385 MPa respectively. The gears are made by hobbing process. Find the tooth bending strength of both wheels and the maximum power that can be transmitted by the drive with a factor of safety 1.5. The layout diagram is shown in the Fig 2. (16-2/3)

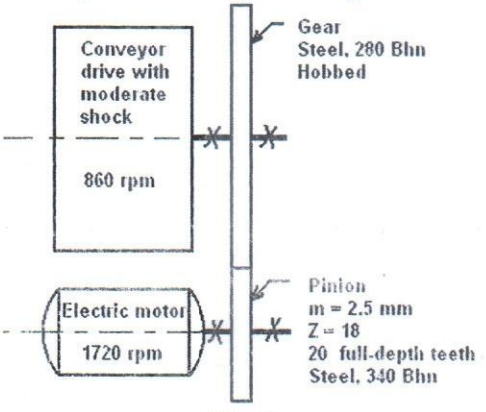


Fig.2

3. The bevel pinion shown in Fig.3 rotates at 960 rev/min in the clockwise direction, viewing from the right side and transmits 5 kW to the gear. The mounting distances, the location of all bearings, and the radii of the pitch circles of the pinion and gear are shown in pitch cones in the figure. Bearings A and C should take the thrust loads. Find the bearing forces on the gear shaft (16-2/3)

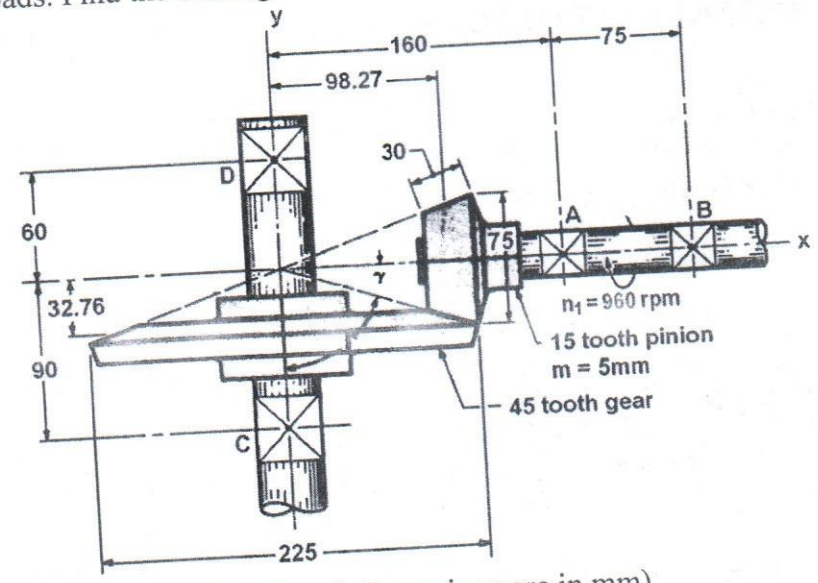


Fig. 3 (All dimensions are in mm)

4. a) A 20° straight-tooth bevel pinion having 14 teeth and a diametral pitch of 6 teeth/in drives a 32-tooth gear. The two shafts are at right angles and in the same plane. Find: (4-2/3)

(a) The pitch angles
(b) The pitch diameters
(c) The cone distance

b) A parallel helical gearset uses a 20-tooth pinion driving a 36-tooth gear. The pinion has a right-hand helix angle of 30°, a normal pressure angle of 25°, and a normal diametral pitch of 4 teeth/in. Find: (12)

(a) The normal, transverse, and axial circular pitches
(b) The normal base circular pitch
(c) The transverse diametral pitch and the transverse pressure angle
(d) The addendum, dedendum, and pitch diameter of each gear

Table 10.11 -Overload factor K_o

	Driven Machinery		
Source of power	Uniform	Moderate Shock	Heavy Shock
Uniform	1.00	1.25	1.75
Light shock	1.25	1.50	2.00
Medium shock	1.50	1.75	2.25

Table 10.12 Load distribution factor K_m

	Face width (mm)			
Characteristics of Support	0 - 50	150	225	400 up
Accurate mountings, small bearing clearances, minimum deflection, precision gears	1.3	1.4	1.5	1.8
Less rigid mountings, less accurate gears, contact across the full face	1.6	1.7	1.8	2.2
Accuracy and mounting such that less than full-face contact exists	Over 2.2	Over 2.2	Over 2.2	Over 2.2

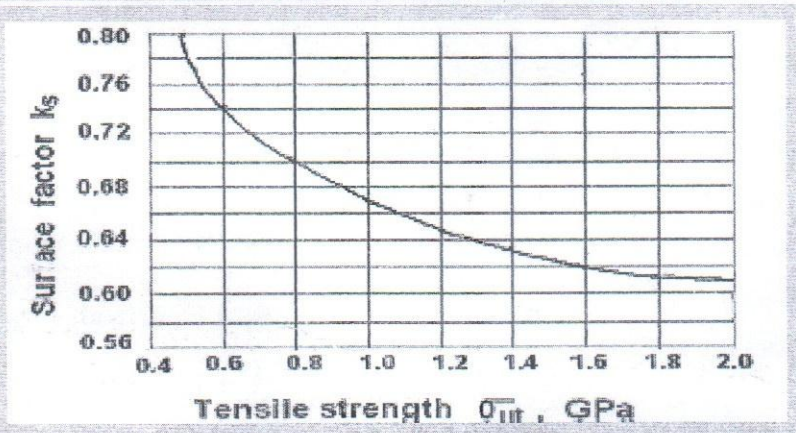


Fig. 10. 4 Surface factor k_s

Table 10.13 Reliability factor K_r

Reliability factor R	0.50	0.90	0.95	0.99	0.999	0.9999
Factor K_r	1.000	0.897	0.868	0.814	0.753	0.702

The modified Lewis equation for bending stress is,

$$\sigma = \frac{F_t}{K_v' b Y m} \qquad (7.13)$$

where K'v is known as velocity factor and is given by Barth's equation below for known pitch line velocity V in m/s and is given by,

$$K_v' = \frac{6}{6+V} \qquad (7.14)$$

Eqn. (7.14) is used for cut or milled teeth or for gears not carefully generated.

$$K_v' = \frac{50}{50+(200V)^{0.5}} \qquad (7.15)$$

Eqn. (7.15) is used for hobbed and shaped gears.

$$K_v' = \left[\frac{78}{78+(200V)^{0.5}}\right]^{0.5} \qquad (7.16)$$

Eqn. (7.16) is used for high-precision shaved or ground teeth.

The modified Lewis equation given in eqn. 7.13 is used when fatigue failure of the gear teeth is not a problem and a quick estimate is desired for more detailed analysis.

$$\sigma = \frac{F_t}{b\, m\, J} K_v\, K_o\, K_m \qquad (7.17)$$

Endurance limit of the material is given by:

$$\sigma_e = \sigma_e' \; k_L \; k_v \; k_s \; k_r \; k_T \; k_f \; k_m \qquad (7.27)$$

Where, σ_e' endurance limit of rotating-beam specimen

k_L = load factor , = 1.0 for bending loads

From geometry we have normal pitch as

$p_n = p \cos \psi$

Normal module m_n is

$m_n = m \cos \psi$

m_n is used for hob selection.

The pitch diameter (d) of the helical gear is:

$d = Z\, m = Z\, m_n / \cos \psi$

The axial pitch (p_a) is:

$p_a = p / \tan \psi$

For axial overlap of adjacent teeth, $b \geq p_a$

In practice $b = (1.15 \sim 2)\, p_a$ is used.

$F_r = F_n \sin \varnothing_n$

$F_t = F_n \cos \varnothing_n \cos \psi$

$F_a = F_n \cos \varnothing_n \sin \psi$

$F_r = F_t \tan \varnothing$

$F_a = F_t \tan \psi$

$$F_n = \frac{F_t}{\cos \varphi_n \cos \psi}$$

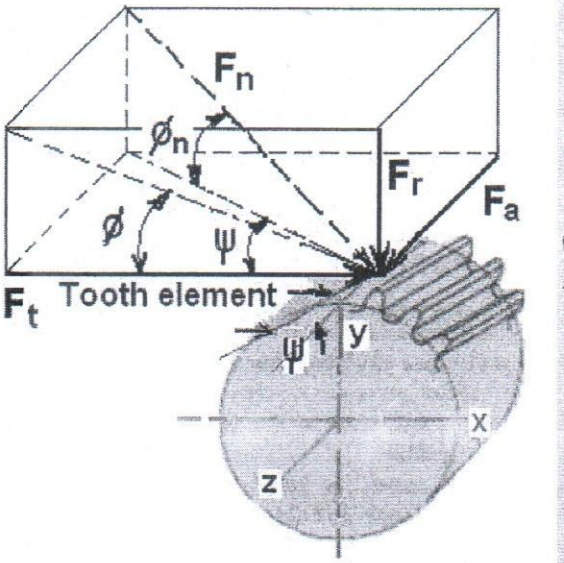
$$F_t = \frac{1000W}{V}$$

$$F_b = F_t / \cos \psi$$

$$F_r = F_b \tan \varnothing_n$$

$$F_r = F_t \tan \varnothing$$

$$\tan \varnothing_n = \tan \varnothing \cos \psi$$



ing on a right hand helical gear

$$d_{av} = d - b \sin\gamma$$

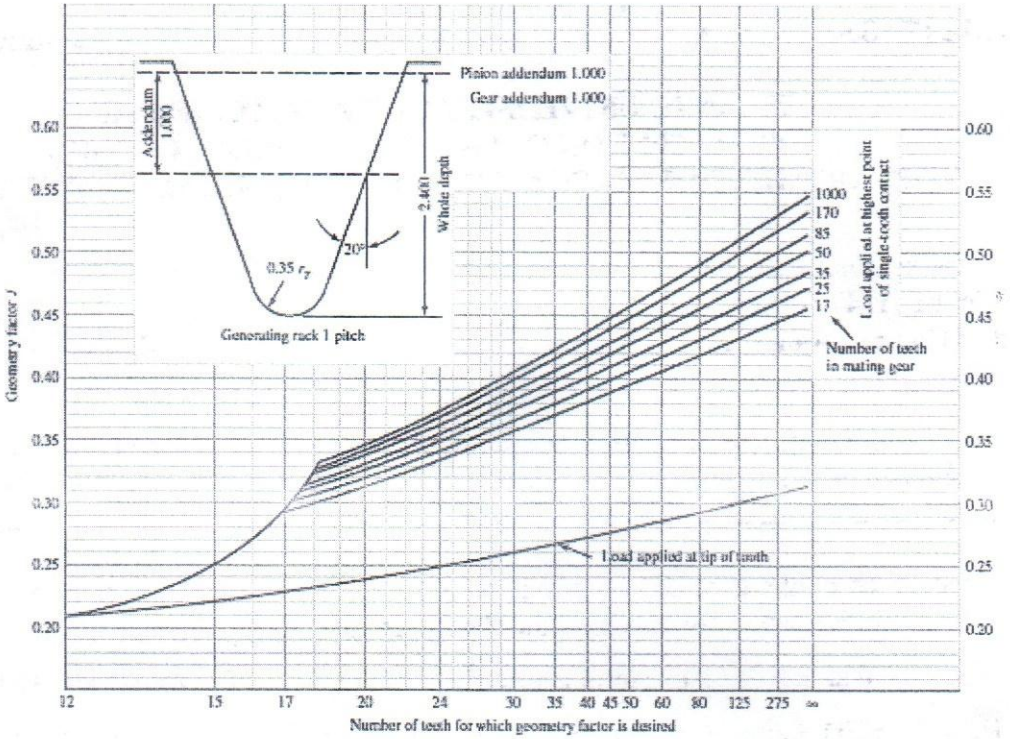
$$V_{av} = \frac{\pi d_{av} n}{6000}$$

$$F_t = \frac{1000W}{V_{av}}$$

$$F_n = F_t / \cos\varphi$$

$$F_r = F_n \cos\gamma = F_t \tan\varphi \cos\gamma$$

$$F_a = F_n \sin\gamma = F_t \tan\varphi \sin\gamma$$



$$P = \frac{N}{d}$$

$$m = \frac{d}{N}$$

$$p = \frac{\pi d}{N} = \pi m$$

$$pP = \pi$$

$$p_t = p_n / \cos\psi$$

$$p_x = p_t / \tan\psi$$

Addendum	$\frac{1.00}{P_n}$
Dedendum	$\frac{1.25}{P_n}$
Pinion pitch diameter	$\frac{N_P}{P_n \cos\psi}$
Gear pitch diameter	$\frac{N_G}{P_n \cos\psi}$
Normal arc tooth thickness†	$\frac{\pi}{P_n} - \frac{B_n}{2}$
Pinion base diameter	$d \cos\phi_t$
Gear base diameter	$D \cos\phi_t$
Base helix angle	$\tan^{-1}(\tan\psi \cos\phi_t)$

BSc.Eng. ME (7th Sem) 12 March 2019 (Afternoon)

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

Mid Semester Examination
Course Code: **MCE 4711**
Course Title: **Computational Fluid Dynamics**

Winter Semester : **A.Y. 2018-2019**
Time : **1.5 Hours**
Full Marks : **75**

There are 04 (Four) Questions. Answer any 03 (Three) of them.
Figures in the margin indicate the full marks. Do not write on the Question Paper.

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1 a) What is computational fluid dynamics (CFD)? Discuss how CFD has emerged as a multidisciplinary tool for solving fluid dynamics and heat transfer problem. (7)

b) Discuss advantages and limitations of using computational fluid dynamics (CFD). (10)

c) How is CFD being used in the power-generation industry? What kinds of data are collected and how are they useful in increasing the efficiency of power generation? (8)

2 a) What are the main elements involved in a complete CFD analysis? Explain the purpose of the first element in detail. (12)

b) What is discretization? Discuss different discretization methods used in fluid dynamics. (13)

3 a) What are the governing equations of CFD? Which fundamental principles do they represent? (5)

b) Derive the continuity equation for an arbitrary control volume V fixed in space and time. (10)

c) Consider a laminar boundary layer that can be approximated as having a velocity profile $u(x) = U_\infty y/\delta$ where $\delta = cx^{1/2}$, c is a constant, U_∞ is the free-stream velocity and δ is the boundary-layer thickness. Sketch the boundary layer considering two-dimensional flow over a flat plate and determine the vertical component of velocity inside the boundary layer. (10)

4 Derive the equation for the conservation of energy in two-dimensional form considering incompressible fluid flow in cartesian coordinate. Explain briefly the significance of each term. (20) (5)

BSc.Eng. (MCE)/7th Semester 8 March 2019 (Afternoon)

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

Mid Semester Examination — Winter Semester, A.Y. 2018-2019
Course Code: Hum 4717 — Time : 1½ Hours
Course Title: Engineering Economy and Finance — Full Marks : 75

There are **4 (Four)** Questions. Answer any **3 (Three)** of them.
Assume reasonable value if required. Marks in the Margin indicate the full marks.
Factor table is provided at the end of the question.

---

1 a) Derive the following equation where symbols have their usual meanings 10

$$P = F\left[\frac{1}{(1+i)^n}\right]$$

b) Write down four differences between a cooperative and a limited company. 4

c) Write down three main differences between Conventional and Islamic Banking, and describe Bai Muazzal mode of Islamic finance with a numerical example. 11

2 a) What do you understand by pay back period? A new process for manufacturing laser levels will have a first cost of $36,000 with annual costs of $17,000. Extra income associated with the new process is expected to be $23,000 per year. What is the pay-back period at $i = 0\%$ and $i = 12\%$ per year? 20

b) BS Corporation assembles 30 trucks per year. Find out the current break even quantity from the following information : 5
Fixed cost : $ 800,000
Variable cost per unit: $35,000
Revenue per unit: $75,000

3 a) Compare the alternatives shown below on the basis of their Present Worth (PW), 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 $2,500 every year	Not Applicable	$ 31,000 at year 3, then increases by 6% every year
Annual Revenue, $/year	400,000	270,000	370,000
Painting cost in 3rd year, $	Not applicable	Not applicable	1,500
Salvage value, $	Not applicable	70,000	100,000
Life, years	3	4	6

b) Describe the rule of 72 with examples. 5

4 a) NX Inc. is considering three machines to use in the production line. Which one should be selected on the basis of Annual Worth(AW) analysis at an interest rate of 12% per year? 17

Item	Machine P	Machine Q	Machine R
Initial Cost, $	275,000	235,000	195,000
Maintenance Cost, $	$ 29,000 at year 3, then increases by 4% every year	$ 27,000, at year 2, then increases by $2,100 every year	$25,000 every year
Annual income, $/year	140,000	150,000	250,000
One time overhauling cost at year 4	$ 9,500	Not applicable	$2,000
Salvage value, $	70,000	Not Applicable	80,000
Life, years	11	5	6

b) Describe Peer to Peer(P2P) financing with an example.. 8

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

BSc.Eng. (MCE)/7th Semester 8 March 2019 (Afternoon)

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

Mid Semester Examination — Winter Semester, A.Y. 2018-2019
Course Code: Hum 4717 — Time : 1½ Hours
Course Title: Engineering Economy and Finance — Full Marks : 75

There are **4 (Four)** Questions. Answer any **3 (Three)** of them.
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12% Compound Interest Factors 12%

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32	37.582	.0266	.00328	.1233	304.848	8.112	7.459	60.501	32
33	42.092	.0238	.00292	.1229	342.429	8.135	7.530	61.261	33
34	47.143	.0212	.00260	.1226	384.521	8.157	7.596	61.961	34
35	52.800	.0189	.00232	.1223	431.663	8.176	7.658	62.605	35
40	93.051	.0107	.00130	.1213	767.091	8.244	7.899	65.116	40
45	163.988	.00610	.00074	.1207	1 358.2	8.283	8.057	66.734	45
50	289.002	.00346	.00042	.1204	2 400.0	8.304	8.160	67.762	50
55	509.321	.00196	.00024	.1202	4 236.0	8.317	8.225	68.408	55
60	897.597	.00111	.00013	.1201	7 471.6	8.324	8.266	68.810	60
65	1 581.9	.00063	.00008	.1201	13 173.9	8.328	8.292	69.058	65
70	2 787.8	.00036	.00004	.1200	23 223.3	8.330	8.308	69.210	70
75	4 913.1	.00020	.00002	.1200	40 933.8	8.332	8.318	69.303	75
80	8 658.5	.00012	.00001	.1200	72 145.7	8.332	8.324	69.359	80
85	15 259.2	.00007	.00001	.1200	127 151.7	8.333	8.328	69.393	85
90	26 891.9	.00004		.1200	224 091.1	8.333	8.330	69.414	90
95	47 392.8	.00002		.1200	394 931.4	8.333	8.331	69.426	95
100	83 522.3	.00001		.1200	696 010.5	8.333	8.332	69.434	100

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B.Sc.Engg/7th Sem.(EEE) 8 March 2019 (Afternoon)

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

Mid Semester Examination — Winter Semester, A.Y. 2018-2019
Course No. Hum 4721 — Time : 1½ hours
Course Title: Engineering Economics — Full Marks : 50

There are **4** (Four) Questions. Answer any **3** (Three) of them.
Use the graph paper wherever necessary. Marks in the Margin indicate the full marks.

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1 a) Who are Engineers in appropriate sense? Explain why the subject of engineering economy is important to practicing engineers. Write the key points. 5

b) Explain the meaning of the statement with an example, "the engineering decision is among alternatives." 4

c) State the relationship or coherence between engineering design process and engineering economic analysis procedure. 4

d) A farm owner who is 5 km away from the nearest public power line wishes to consider providing electricity for the farm. What alternatives do you see that might be possible? Make any reasonable assumptions. $3^2/_3$

2 a) Suppose you are thinking to produce an electronic timing switch, the direct material, direct labor and direct overhead costs per unit have been estimated to be Tk50, Tk8 and Tk4 respectively. The selling price is decided to be 138 percent of the variable cost per unit. The maximum capacity of the firm is 160,000 units per year. Its fixed cost is Tk2,024,000 per year. For this firm:

i. Find the breakeven quantity in units and in percentage of total capacity. 3

ii. What is the percentage reduction in breakeven point if fixed costs are reduced 10 percent; if variable cost per unit is reduced 10 percent; if both costs are reduced 10 percent; and if the selling price is increased by 10 percent? 6

b) When the revenue and the total cost functions are respectively $R = 1000Q - 0.001Q^2$, and $TC = 0.005Q^2 + 4Q + 20000$. $7^2/_3$

i. What is the profit function?
ii. What quantity you must produce to maximize profit?
iii. What is the BEP(Q)?
iv. Find the quantity to be produced to maintain the average cost. Make comment on acceptable result.

3 a) *Riba*-based economy was unlawful in divine Books. Write an impressive short note on it. 5

b) What do you understand by money? Why is money having time preference? 3

c) Tk100,000 compounded monthly at the rate 1% per month. The same amount is compounded annually at 12% per annum. Calculate the amounts owed at the end of the year under both plans. Then find the nominal interest rate and effective interest rate? Which one is greater and why? If the nominal rate is 24% compounded monthly, what would be effective rate? How it is different from the nominal rate 12% compounded monthly? $8^2/_3$

4 a) Using interest tables and interpolation as per as possible, determine the approximate rates of interest indicated by the following valuations of prospective series of future cash receipts: 9

i. Tk8,000 now for Tk1,300 at the end of each year for 10 years.

ii. Tk10,000 now for Tk300 at the end of first year, Tk350 at the end of the second year, and receipts increasing by Tk50 at the end of each year to a final receipt of Tk1,250 at the end of 20th year.

iii. Tk5,000 now for Tk225 at the end of each year forever.

Draw the necessary cash-flow diagrams.

b) What is inflation? How is consumer price index (CPI) a measure of inflation? $7^2/_3$

A company is producing electric meters. An investment of Tk5,000,000 is required now (2019) in a new market scheme. The company is accustomed to obtaining a 15% RoR on its projects during inflation-ridden periods for the last few years. Using non-linear regression analysis, additional profits estimated are:

Table for Q4b)

Year	1	2	3	4	5	6
Additional profit	100 k	120 k	150 k	200 k	150 k	100 k

An inflation is projected to be 9% per year. The company expects at least a 10% inflation-free return on its investment.

i. Deflate the cash flow at 9%.

ii. Use the deflated cash flow and thus compute the present value using the constant-money cash flow with interest rate of 10%.

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B.Sc.Eng/7th Sem.(ME)/BScTE (1-yr/2-yr) 5 March 2019 (Afternoon)

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

Mid Semester Examination — Winter Semester, A.Y. 2018-2019
Course No. MCE 4729/MCE4793 — Time : 1½ hours
Course Title: Production and Operations Management — Full Marks : 75

There are **4** (Four) Questions. Answer any **3** (Three) of them.
Use the graph paper wherever necessary. Marks in the Margin indicate the full marks.

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1 a) State the meaning and functions of industrial engineering. 6

b) Explain the scope of production and operations management along with the aspects being covered. 6

c) Manufacturing today faces acute competition and encounters several criteria concurrently. Mentioning the major criteria, state the major characteristics of present manufacturing operations planning. Answer only in point form. 8

d) State the characteristics of operations management decision-making. 5

2 a) Why must a manufacturing/industrial system have feedback and feedforward mechanisms? Demonstrate your answer by a figure. 8

b) Pointing to the wholeness concept of an industrial system, give reasons why an industrial engineer should make effort to avoid sub-optimization (insular and temporal). Give the appropriate examples/diagrams. 9

c) What are the principal manufacturing environments under which different manufacturers operate? Depict the product positioning strategies under these environments. 8

3 a) ABC Ltd. and XYZ Ltd. anticipate sales turnover amounting to Tk. 2,500,000, 10% of which is expected to be profit if each achieves 100% of normal capacity. The variable costs are Tk. 1,350,000 for ABC Ltd. and Tk. 2,000,000 for XYZ Ltd. Find the following 15

i. Contribution, profit, and fixed costs of each companies
ii. Present the necessary details graphically on a single break-even chart, and
iii. Determine therefrom the capacity at each of the break-even points lie.

b) When $v = 1{,}000$/unit, $p = 21{,}000/Q^{1/2}$ and $F = 10{,}000$ per period, where symbols carry their usual meanings and money could be any currency you consider. 10

i. Find BEP(Q) and BEP(C/R). Comment on the result(s).
ii. What should be the quantity to be produced to maximize profit? Compare the BEP(Q) result and this quantity and make any reasonable comment.

4 a) What are the main advantages of quantitative techniques over qualitative techniques in demand forecasting? 5

b) What is the purpose of establishing control limits for forecast error? State the mathematical formulas and differentiate the use of mean absolute deviation (MAD) and mean square error (MSE) in justifying a quantitative demand forecast technique. 8

c) Two different forecasting techniques (say F_1 and F_2) were used to forecast the demand of a product. Actual demand and the corresponding sets of forecasts are as follows: 10

Table for Q4(c)

Period	Actual demand	Predicted demand F_1	Predicted demand F_2
1	68	66	66
2	75	68	68
3	70	72	70
4	74	71	72
5	69	72	74
6	72	70	76
7	80	71	78
8	78	74	80

i. Compute MAD for each set of forecast and comment, which forecast appears to be more accurate.

ii. Compute MSE for each set of forecast and comment, which forecast appears to be more accurate.

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B.Sc. Engg. (M)/7th Sem March 12, 2019 (Afternoon)

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination
Course No.: MCE 4787
Course Title: Automobile Engineering

Winter Semester, A. Y. 2018-2019
Time: 1 Hours 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.

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1. a) Classify automobile chassis? Briefly explain the different components of an automobile chassis. 15
   b) Describe the function of an over running clutch in a starter motor with necessary diagram. 10

2. a) Describe the carburetor operation at idle and normal speed condition. 15
   b) What is an oxygen sensor? Why it is necessary in automobile? In case of malfunctioning of an oxygen sensor, what are the signs? 10

3. a) How a catalytic converter converts the harmful exhaust gases to less toxic mixture of carbon dioxide (CO_2), Nitrogen (N_2) and Water vapors (H_2O) in its different stages. Explain with necessary diagrams and chemical reactions. 15
   b) Why the torque of an engine drops with the increase of engine speed after a certain point? Also, explain why the horsepower of the engine still keep increases at that point? 10

4. a) Discuss in detail the constructional features and functions of an engine clutch. Explain clearly the problems in engine system if there is no clutch in the manual transmission. 15
   b) Describe the working of a synchromesh gear box with the help of a neat sketch. What are the merits and demerits of it compared to sliding mesh and constant mesh gear boxes? 10

65

M.Sc.Engg. (M)/ MScTE (1sem) 11 March, 2019 (Afternoon)

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

MID SEMESTER EXAMINATION
MCE 6109 Mechanical Vibrations

WINRER SEMESTER: 2018-2019
TIME : $1\frac{1}{2}$ HRS
FULL MARKS : 75

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 hoisting drum, carrying a steel wire rope, is mounted at the end of a cantilever beam as shown in Fig. 1. Determine the equivalent spring constant of the system when the suspended length of the wire rope is l. The width of the beam is a. Assume that the net cross-sectional diameter of the wire rope is d and the Young's modulus of the beam and the wire rope is E. (12)

   b) Determine the equivalent mass of the shown in Fig. 2. (13)

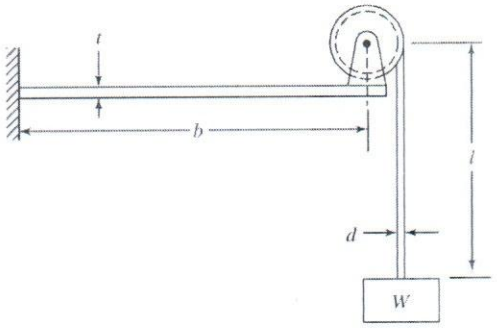


Fig.1

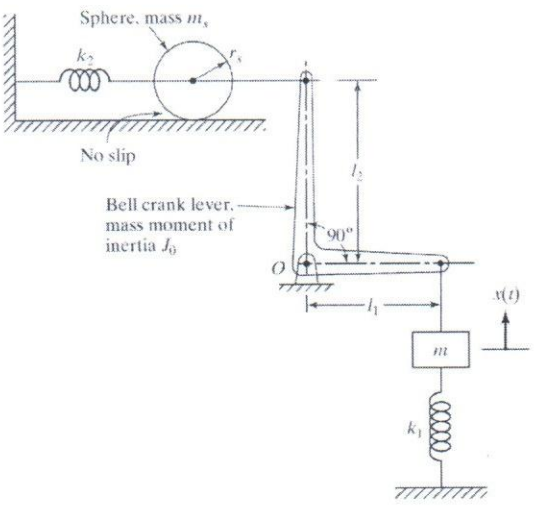


Fig. 2

2. a) Derive the expression of logarithmic decrement δ in terms of damping ratio ζ if the damping ratio is smaller than 1. (7)

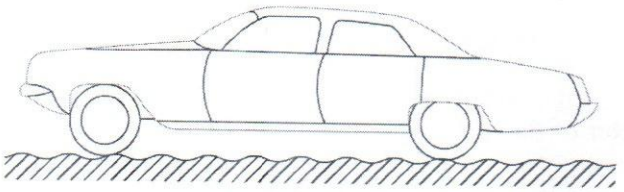
   b) A column of the water tank is 100 m high and is made of reinforced concrete with a tubular cross section of inner diameter 2.4 m and outer diameter 3.0 m. The tank weighs 2669 kN when filled with water. By neglecting the mass of the column and assuming the Young's modulus of reinforced concrete as 27.6 GPa, determine the following: (18)

   i) the natural frequency and the natural time period of transverse vibration of the water tank.
   ii) the vibration response of the water tank due to an initial transverse displacement of 10 cm.
   iii) the maximum values of the velocity and acceleration experienced by the water tank.

3. a) What do you mean by coulomb friction? Derive the expression of the number of half cycles the vibration occurs before the motion ceases. Then, discuss the characteristics of a system with coulomb damping. (17)

   b) A metal block, placed on a rough surface, is attached to a spring and is given an initial displacement of 10 cm from its equilibrium position. After five cycles of oscillation in 2 s, the final position of the metal block is found to be 1 cm from its equilibrium position. Find the coefficient of friction between the surface and the metal block. (8)

4. An automobile moving over a rough road can be modeled considering (a) weight of the car body, passengers, seats, front wheels, and rear wheels; (b) elasticity of tires (suspension), main springs, and seats; and (c) damping of the seats, shock absorbers, and tires. Develop three mathematical models of the system using a gradual refinement in the modeling process. Discuss the number of natural frequencies according to the models. (25)



M Sc.Engg.(MCE) 04 March 2019 (Afternoon)

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

Mid Semester Examination
Course Code :MCE 6145
Course Title: Convective Heat Transfer

Winter Semester: A.Y. 2018-2019
Time : 1½ hours
Full Marks : 75

OPEN BOOK

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.

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1. **a)** The velocity profile u(x,y) for boundary layer flow over a flat plate is given by **10**

$$\frac{u(x,y)}{u_\infty} = \frac{3}{2}\left[\frac{y}{\delta(x)}\right] - \frac{1}{2}\left[\frac{y}{\delta(x)}\right]^3$$

Where the boundary layer thickness is $\delta(x) = \sqrt{\frac{280}{13}\frac{\vartheta x}{u_\infty}}$.

Develop an expression for the local drag coefficient. Also develop an expression for the average drag coefficient over a distance x=L from the leading edge of the plate.

b) A square plate 0.5 m by 0.5 m thermally insulated on one side and subjected to a solar radiation flux $q = 600\ W/m^2$ on the other side which is considered a black surface. The plate makes an angle -60° with the vertical, so that the hot surface is facing upward. The heated surface dissipates heat by free convection into quiescent atmospheric air at $T_\alpha = 300\ K$. **15**

The physical properties of air are:
$v = 2.33\ x\ 10^{-5} m^2/s)$, $k = 0.032\ W/(m.°C)$, $Pr = 0.693$, $\beta = 3.08\ x\ 10^{-3}$, $Gr_c = 10^8$.

Calculate the *equilibrium temperature* of the plate.

2. **a)** Discuss the thermal boundary layer concept for the flow of a hot fluid over a cold wall. **10**

b) Air at atmospheric pressure and temperature $T_1 = 325\ K$ flows through a tube bundle in in-line tube arrangement. Tubes have an outside diameter of 1.9 cm and are maintained at a uniform temperature $T_w = 375\ K$. The longitudinal and transverse pitches for the bundle are given by $S_T = S_L = 2D$. The bundle consists of tubes $L = 0.75\ m$ long tubes, $N = 15$ tube rows in the direction of flow, and $m = 20$ tubes per row. The air velocity just before the tube bank is $u_\alpha = 8\ m/s$. **15**

(i). Find the pressure drop ΔP across the tube bundle.
(ii). Determine the heat transfer coefficient h_m.
(iii). Find the exit temperature T_2 of the air.
(iv). Determine the total heat transfer rate Q.

The physical properties of atmospheric air at 350 K are taken as:
$c_p = 1009\ J/(kg.°C)$, $\rho = 0.998\ kg/m^3$, $k = 0.03\ W/(m.°C)$,
$\mu = 2.075x10^{-5}\ kg/(m.s)$, $Pr = 0.697$

3. **a)** Water flows with a mean velocity of 2 m/s inside a circular pipe of inside diameter of 5 cm. The pipe is of commercial steel and its wall is maintained at a uniform temperature of 100°C by condensing steam on its outer surface. At a location where the fluid is hydrodynamically and thermally developed, the bulk mean temperature of water is 60°C. Properties at bulk mean temperature for water are given as follows: **15**

ρ=985 kg/m^3, Pr=3.02, $\mu_b = 4.71\ x \frac{10^{-4} kg}{m.s}$, $\mu_w = 2.82\ x\ 10^{-4}\ kg/(m.s)$, f=0.0152

Calculate the heat transfer coefficient h for a smooth pipe by using the following correlations:
(a). The Notter and Sleicher equation.
(b). The Petukhov equation.
(c). The Sieder and Tate equation.

b) Ethylene glycol at $60°C$ with a velocity of $u_m = 4\ cm/s$, enters the 6 m long , heated section of a thin walled, 2.5 cm ID tube, after passing through an isothermal calming section. In the heated part, the tube wall is maintained at a uniform temperature $T_w = 100°C$ by condensing steam on the outer surface of the tube. **10**

The physical properties of fluid at the inlet temperature are: $c_p = 2562\ J/(kg.°C)$, $\rho = 1088\ kg/m^3$, $k = 0.26\ W/(m.°C)$, $v = 4.75x10^{-6} m^2/s$, $Pr = 51$, $Nu_m = 5.5$.

Calculate the *exit temperature* of the ethylene glycol.

4. **a)** Discuss the physical significance of the dimensionless groups Reynolds, Prandtl, Nusselt, Stanton and Eckert numbers. **10**

b) The exact expression for the local Nusselt number for laminar flow along a flat plate is given by $Nu_x = \frac{h(x)x}{k} = 0.332\ Pr^{\frac{1}{3}} Re^{\frac{1}{2}}$. **15**

(i). Develop a relation for the average heat transfer coefficient h(x) from x=0 to x=L. Atmospheric air at $T_\infty = 400K$ with a velocity $u_\infty = 1.5\ m/s$ flows over a flat plate L=2m long maintained at a uniform temperature $T_w = 300K$.

(ii). Calculate the *average heat transfer coefficient* h_m from x=0 to x=L=2 m.

(iii). Calculate the *heat transfer rate* from airstream to the plate from x=0 to x=L=2 m for w=0.5 m.

M.ScEng/PhD (ME) 8 March 2019 (Afternoon)

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

Mid-Semester Examination — Winer Semester, A.Y. 2018-2019
Course No. MCE 6221 — Time :1 1/2 hours
Course Title: Quality Assurance and Management — Full Marks :75

There are **4** (FOUR) Questions. Answer any **3** (THREE) of them.
Use the graph paper wherever necessary. Marks in the Margin indicate the full marks.

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1. a) An engineer observes several responses for a variable of interest. The average of these recorded measurements is exactly what the engineer desires for any single responses. Why should the engineer be concerned about variability in this context? How does the engineer's concern relate to quality? Give a convincing answer. 8
   b) What is the difference between quality conformance and quality performance? Explain with examples. 5
   c) Write, at least five points, on significance of learning of quality assurance and management topics in today's manufacturing context. 7
   d) What is understood by critical-to-quality (CTQ) characteristic? Point out the types of CTQ characteristics that should be possessed by a product. 5

2. a) A quality assured production system has to be vibrant in order to create values and satisfy customer needs and expectations. By a figure show a production system elements' and their connectivity that will fulfill these goals. 7
   b) Select a product of your choice. Describe the physical performance, economic performance, timeliness performance, and customer service performance that you need or expect. 7
   c) Explain Customer's experience of quality and Producer's creation of quality through a process. Give examples. 6
   d) State and discuss two hypotheses about customers on quality. 5

3 a) Realizing the concept of the term methodology explain why statistical methodology is an unavoidable part of quality assurance practice. 6
   b) State the names of management as well as some advanced tools and techniques used in quality assurance to come up with a comprehensive analysis. 6
   c) Use the following data table and draw the necessary Pareto diagrams. Where the company should be concentrating their improvement efforts? How is the focus different between the check sheet information and cost information? 13

Finish flaws		Cost
Scratches	///// ///	145
Dents	//	200
Surface finish disfigurations in paint	////	954
Damage to casing	/	6500
Wrong color	/	200
Operational flaws		
Mounting plate location off-center	///// ///// /	75
Nonfunctional electrical system	//	5000
Activation switch malfunction	/	300
Motor failure	////	420

4 a) "No more trade-off between quality and productivity, rather they are synergic". Enumerate the critical observations about their connection. 5
   b) Suppose you have drawn a control chart and found that the plotted statistics appearing in a variable control chart hug the center line with little scatter around. Explain why this is not necessarily a good sign. 5

c) What practical implication relative to control chart in terms of process operation do type I and type II errors have? 5

d) Suppose you are producing oil seals in large numbers and want to establish $\bar{x}$and R control charts to monitor your production process. You have collected 25 samples of uniform size 4 each on the internal diameter of the seal. The summarized information are: 10

$$\sum_{i=1}^{25} \bar{x}_i = 1{,}253.75\ mm \text{and} \sum_{i=1}^{25} R_i = 14.08\ mm$$

i. Find the control limits that should be used on the $\bar{x}$ and R control charts.

ii. Assume that the 25 preliminary samples plot in control on both charts. Estimate the process mean and standard deviation.

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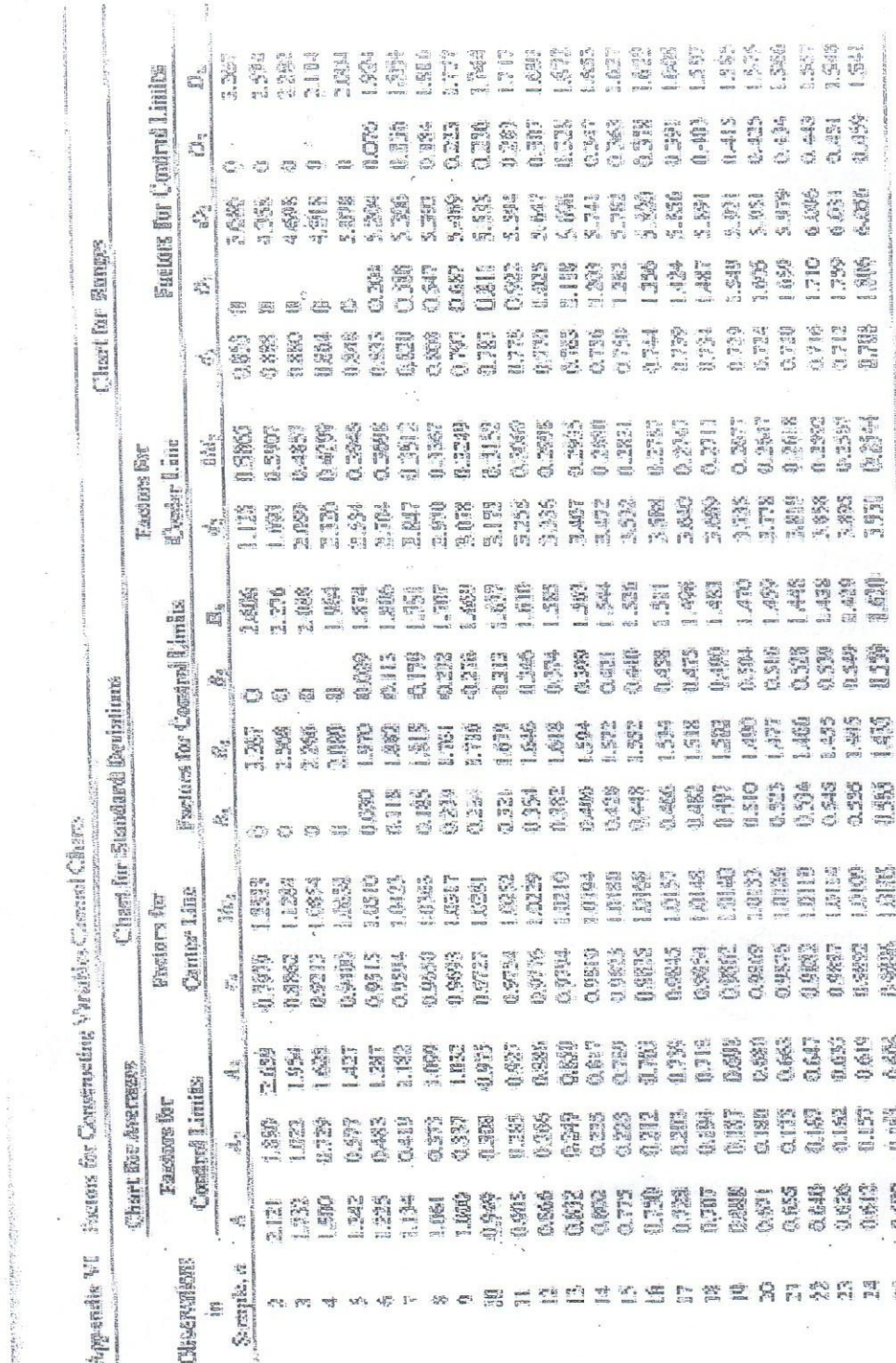

Appendix VI Factors for Computing Variables Control Charts

Observation or Sample, n	Chart for Averages: Factors for Control Limits A	A_2	A_3	Factors for Center Line c_4	$1/c_4$	Chart for Standard Deviations: Factors for Control Limits B_3	B_4	B_5	B_6	Factors for Center Line d_2	$1/d_2$	d_3	Factors for Control Limits D_1	D_2	D_3	D_4
2	2.121	1.880	2.659	0.7979	1.2533	0	3.267	0	2.606	1.128	0.8865	0.853	0	3.686	0	3.267
3	1.732	1.023	1.954	0.8862	1.1284	0	2.568	0	2.276	1.693	0.5907	0.888	0	4.358	0	2.574
4	1.500	0.729	1.628	0.9213	1.0854	0	2.266	0	2.088	2.059	0.4857	0.880	0	4.698	0	2.282
5	1.342	0.577	1.427	0.9400	1.0638	0	2.089	0	1.964	2.326	0.4299	0.864	0	4.918	0	2.114
6	1.225	0.483	1.287	0.9515	1.0510	0.030	1.970	0.029	1.874	2.534	0.3946	0.848	0	5.078	0	2.004
7	1.134	0.419	1.182	0.9594	1.0423	0.118	1.882	0.113	1.806	2.704	0.3698	0.833	0.204	5.204	0.076	1.924
8	1.061	0.373	1.099	0.9650	1.0363	0.185	1.815	0.179	1.751	2.847	0.3512	0.820	0.388	5.306	0.136	1.864
9	1.000	0.337	1.032	0.9693	1.0317	0.239	1.761	0.232	1.707	2.970	0.3367	0.808	0.547	5.393	0.184	1.816
10	0.949	0.308	0.975	0.9727	1.0281	0.284	1.716	0.276	1.669	3.078	0.3249	0.797	0.687	5.469	0.223	1.777
11	0.905	0.285	0.927	0.9754	1.0252	0.321	1.679	0.313	1.637	3.173	0.3152	0.787	0.811	5.535	0.256	1.744
12	0.866	0.266	0.886	0.9776	1.0229	0.354	1.646	0.346	1.610	3.258	0.3069	0.778	0.922	5.594	0.283	1.717
13	0.832	0.249	0.850	0.9794	1.0210	0.382	1.618	0.374	1.585	3.336	0.2998	0.770	1.025	5.647	0.307	1.693
14	0.802	0.235	0.817	0.9810	1.0194	0.406	1.594	0.399	1.563	3.407	0.2935	0.763	1.118	5.696	0.328	1.672
15	0.775	0.223	0.789	0.9823	1.0180	0.428	1.572	0.421	1.544	3.472	0.2880	0.756	1.203	5.741	0.347	1.653
16	0.750	0.212	0.763	0.9835	1.0168	0.448	1.552	0.440	1.526	3.532	0.2831	0.750	1.282	5.782	0.363	1.637
17	0.728	0.203	0.739	0.9845	1.0157	0.466	1.534	0.458	1.511	3.588	0.2787	0.744	1.356	5.820	0.378	1.622
18	0.707	0.194	0.718	0.9854	1.0148	0.482	1.518	0.475	1.496	3.640	0.2747	0.739	1.424	5.856	0.391	1.608
19	0.688	0.187	0.698	0.9862	1.0140	0.497	1.503	0.490	1.483	3.689	0.2711	0.734	1.487	5.891	0.403	1.597
20	0.671	0.180	0.680	0.9869	1.0133	0.510	1.490	0.504	1.470	3.735	0.2677	0.729	1.549	5.921	0.415	1.585
21	0.655	0.173	0.663	0.9876	1.0126	0.523	1.477	0.516	1.459	3.778	0.2647	0.724	1.605	5.951	0.425	1.575
22	0.640	0.167	0.647	0.9882	1.0119	0.534	1.466	0.528	1.448	3.819	0.2618	0.720	1.659	5.979	0.434	1.566
23	0.626	0.162	0.633	0.9887	1.0114	0.545	1.455	0.539	1.438	3.858	0.2592	0.716	1.710	6.006	0.443	1.557
24	0.612	0.157	0.619	0.9892	1.0109	0.555	1.445	0.549	1.429	3.895	0.2567	0.712	1.759	6.031	0.451	1.548
25	0.600	0.153	0.606	0.9896	1.0105	0.565	1.435	0.559	1.420	3.931	0.2544	0.708	1.806	6.056	0.459	1.541

Rev. p. 224

$$A = \frac{3}{c_4\sqrt{n}} \qquad A_2 = \frac{3}{d_2\sqrt{n}} \qquad c_4 = \frac{4(n-1)}{4n-3}$$

$$B_5 = 1 - \frac{3}{c_4\sqrt{2(n-1)}} \qquad B_6 = 1 + \frac{3}{c_4\sqrt{2(n-1)}}$$

$$B_3 = c_4 - \frac{3}{\sqrt{2(n-1)}} \qquad B_4 = c_4 + \frac{3}{\sqrt{2(n-1)}}$$