B.Sc.Engg. (M)/1st Year 14 March, 2018 (Aft.)

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

Semester Mid-term Examination — Winter Semester, A.Y. 2017-2018
Course No. MCE 4101 — TIME : 1.5 Hours
Course Title: Introduction to Mechanical Engineering — Full Marks : 50

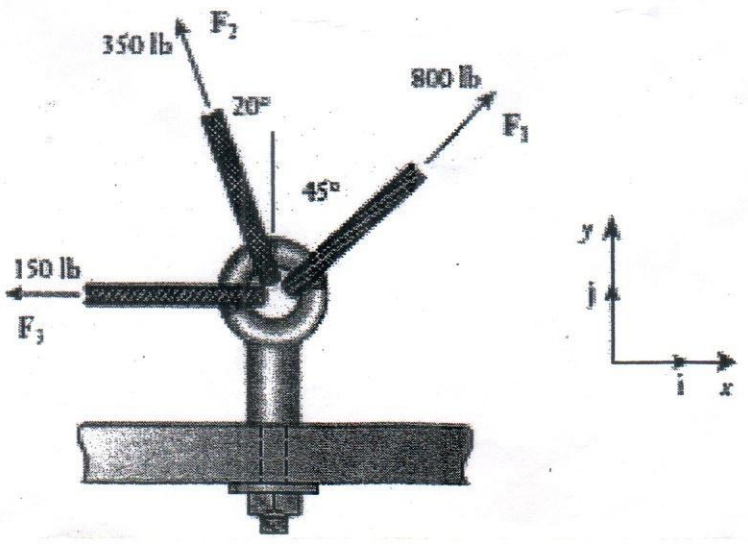
There are 4 (Four) Questions. Answer any 3(Three) Questions.
Marks in the margin indicate full marks.

1. a) What is Engineering and who are Mechanical Engineers? 3
   b) What are the differences between engineers , mathematicians and scientists? 3
   c) Write ten top achievements of Mechanical Engineering Professions. 4
   d) Describe some of the main subjects that comprise the typical mechanical Engineering curricula. 6.6

2. a) Where does life of a new product begin? 4
   b) What are the questions a designer has to answer? 4
   c) Draw the flowchart of prototypical mechanical design process. 8.66

3. a) What are the procedures for converting between the two systems of units: SI and USCS? 4.66
   b) Helium-neon lasers are used in engineering laboratories, in robot vision systems, and even in the barcode readers found in supermarket checkout counters. A certain laser has a power output of 3 mW and produces light of wavelength $\lambda = 632.8$ nm. The lowercase Greek character lambda (λ) is a conventional symbol used for wavelength; . (a) Convert the power rating to horsepower. (b) Convert the wavelength to inches. 6
   c) The specification for a certain residential f re-suppression system is that water should be sprayed at the rate q of 10 gal/min. For the revision of a technical manual intended for customers outside the United States, express the flow rate in the SI based on a time interval of 1 s. 6

4. a) What do you mean by resultant force? Describe the methods that are used to find the resultant force for a given system of forces. 8
   b) The eyebolt is fastened to a thick base plate, and it supports three steel cables with tensions 150 lb, 350 lb, and 800 lb. Determine the resultant force that acts on the eyebolt by using the vector algebra approach. The unit vectors i and j are oriented with the *x-y* coordinates as shown. 8.66



Quantity	Conversion		
Length	1 in.	=	25.4 mm
	1 in.	=	0.0254 m
	1 ft	=	0.3048 m
	1 mi	=	1.609 km
	1 mm	=	3.9370×10^{-2} in.
	1 m	=	39.37 in.
	1 m	=	3.2808 ft
	1 km	=	0.6214 mi
Area	1 in^2	=	645.16 mm^2
	1 ft^2	=	9.2903×10^{-2} m^2
	1 mm^2	=	1.5500×10^{-3} in^2
	1 m^2	=	10.7639 ft^2
Volume	1 ft^3	=	2.832×10^{-2} m^3
	1 ft^3	=	28.32 L
	1 gal	=	3.7854×10^{-3} m^3
	1 gal	=	3.7854 L
	1 m^3	=	35.32 ft^3
	1 L	=	3.532×10^{-2} ft^3
	1 m^3	=	264.2 gal
	1 L	=	0.2642 gal
Mass	1 slug	=	14.5939 kg
	1 lbm	=	0.45359 kg
	1 kg	=	6.8522×10^{-2} slugs
	1 kg	=	2.2046 lbm
Force	1 lb	=	4.4482 N
	1 N	=	0.22481 lb
Pressure or stress	1 psi	=	6895 Pa
	1 psi	=	6.895 kPa
	1 Pa	=	1.450×10^{-4} psi
	1 kPa	=	0.1450 psi

Quantity	Conversion		
Work, energy or heat	1 ft · lb	=	1.356 J
	1 Btu	=	1055 J
	1 J	=	0.7376 ft · lb
	1 J	=	9.478×10^{-4} Btu
Power	1 (ft · lb)/s	=	1.356 W
	1 hp	=	0.7457 kW
	1 W	=	0.7376 (ft · lb)/s
	1 kW	=	1.341 hp

2

B.Sc. Engg. (M) -1st Sem. 13 March 2018 (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) Two forces act on the screw eye as shown in Figure 1a. If F = **600 N**, determine the magnitude of the resultant force and the angle θ, if the resultant force is directed vertically upward.

   (b) The bolt is subjected to the force F, which has components acting along the x, y, z axes as shown in Figure 1b. If the magnitude of F is **80 N**, and $\alpha = 60^\circ$ and $\beta = 45^\circ$, determine the magnitudes of its components.

2. (a) Determine the mass of each of the two cylinders if they cause a sag of $s = 0.5$ **m** when suspended from the rings at A and B as shown in Figure 2a. Note that $s = 0$ when the cylinders are removed.

   (b) The total hip replacement is subjected to a force of $F = 120$ **N** as shown in Figure 2b. Determine the moment of this force about the neck at A and the stem at B.

3. (a) The horizontal beam is supported by springs at its ends as shown in Figure 3a. Each spring has a stiffness of $k = 5$ **kN/m** and is originally unstretched when the beam is in the horizontal position. Determine the angle of tilt of the beam if a load of **800 N** is applied at point C.

   (b) Determine the force in each member of the truss as shown in Figure 3b and state if the members are in tension or compression. Set $P_1 = 1780$ **N**, $P_2 = 1780$ **N**, $P_3 = 0$.

4. (a) Locate the centroid of the area as shown in Fig. 4a.

   (b) Determine the moment of inertia of the area as shown in Fig. 4b about the y axis.

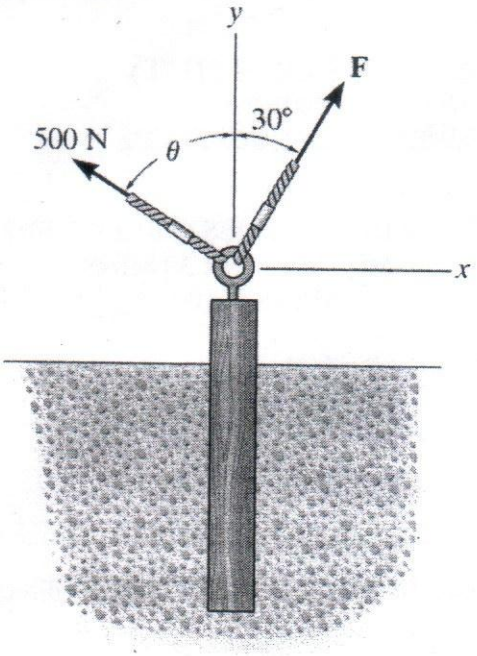

Figure-1a

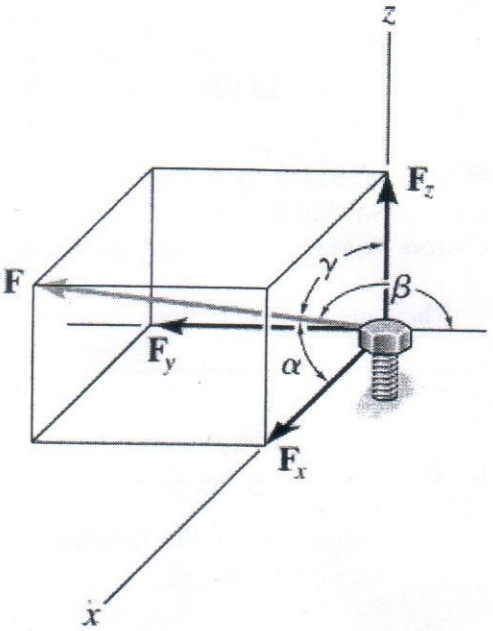

Figure-1b

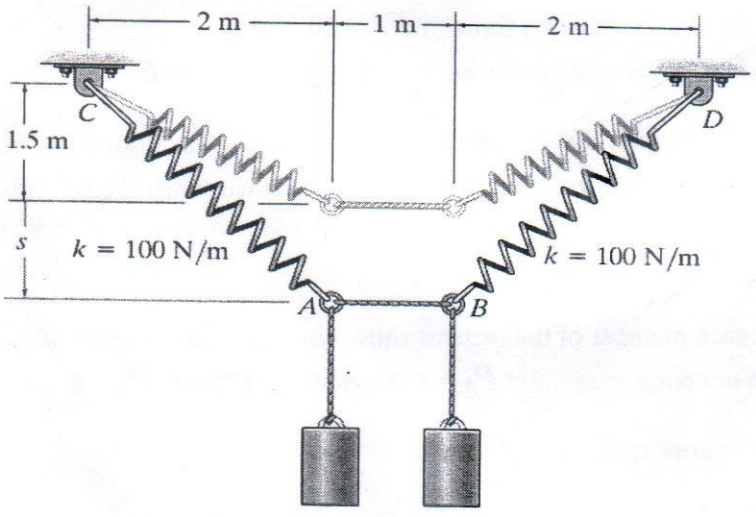

Figure-2a

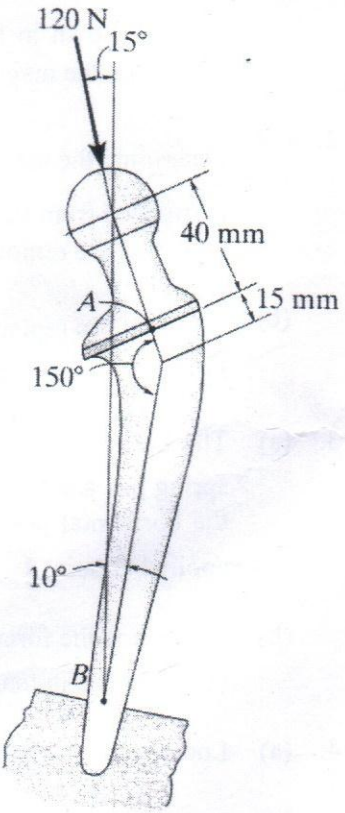

Figure-2b

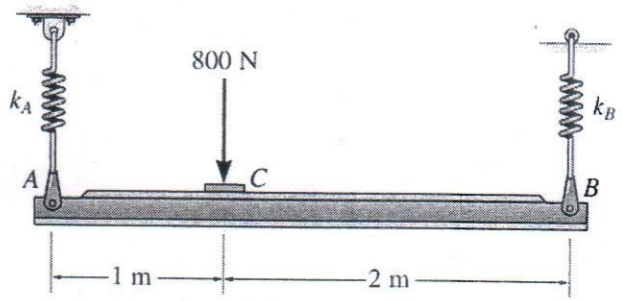

Figure-3a

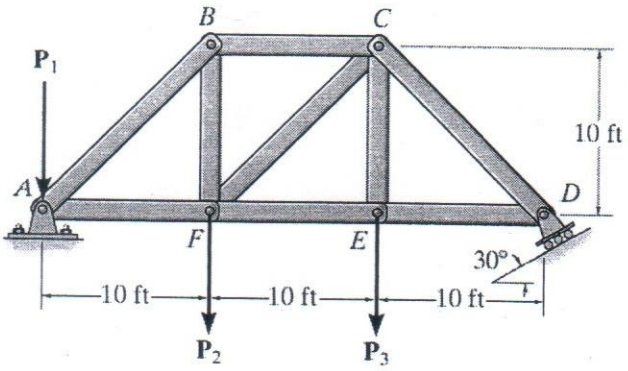

Figure-3b

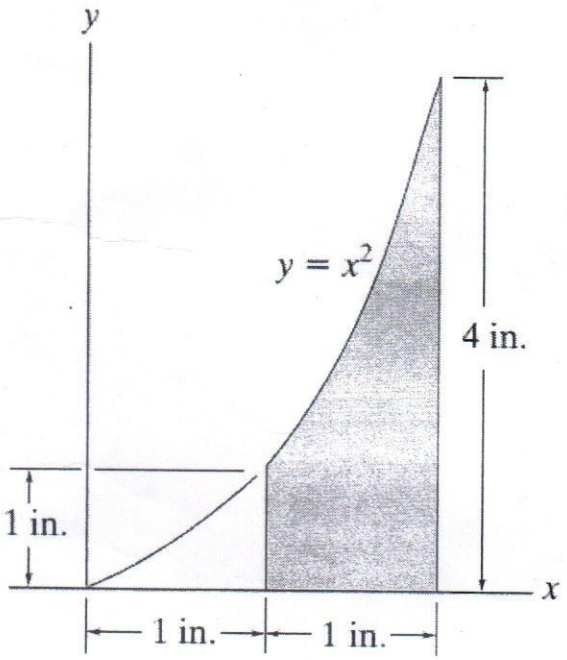

Figure-4a

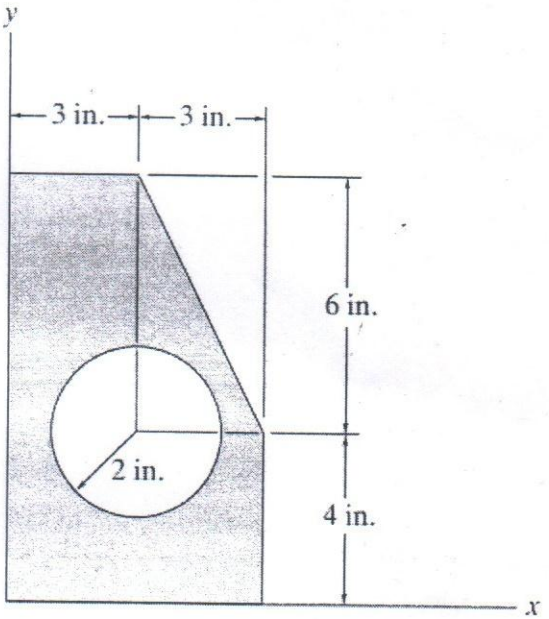

Figure-4b

B Sc. Eng.(M)(1st Semester) **19 March 2018(Afternoon)**

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

Mid Semester Examination — Winter Semester, A.Y. 2017-2018
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) The graph of a function *f* is shown in the figure: 01. Sketch the graphs of the following equations. Also find the domain and range from graphs. **20**

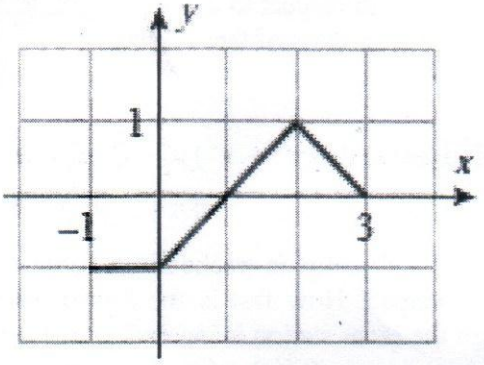

Figure: 01

$(i)\ y=f(x+1)\ (ii)\ y=f(2x)\ (iii)\ y=|f(x)|\ (iv)\ y=1-|f(x)|$

b) Given the graph of *f(x)*, shown in figure : 02, determine if *f(x)* is continuous at x = −2, x = 0 , and x = 3. **13⅓**

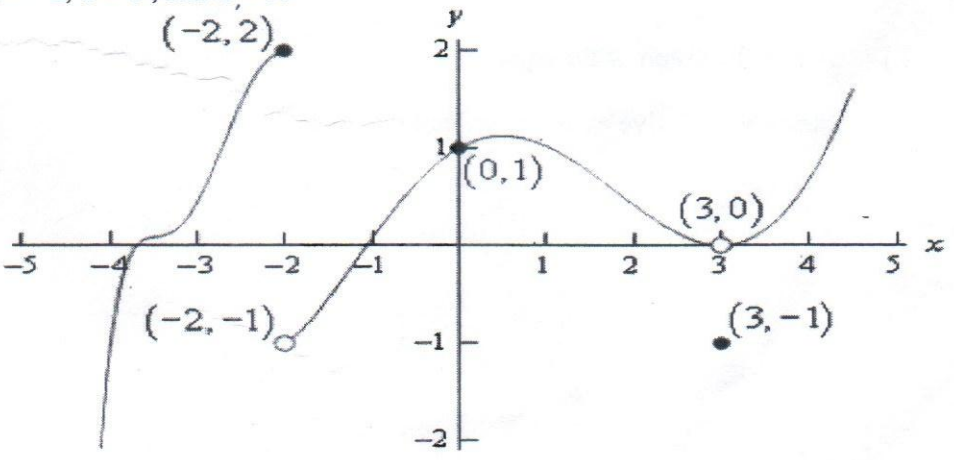

Figure: 02

2. a) An object is released from rest (its initial velocity is zero) from the Empire State Building at a height of 1250 ft above street level (Shown in Figure - 03). The height of the object can be modeled by the position function $s = f(t) = 1250 - 16t^2$. **15**

(i) Verify that the object is still falling at $t = 5$ s.

(ii) Find the average velocity of the object over the time interval from $t = 5$ to $t = 6$ s.

(iii) Find the object's instantaneous velocity at time $t = 5$ s.

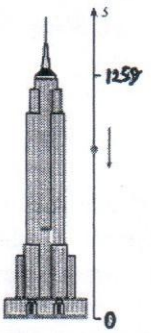

Figure: 03

b) Find the n[th] derivative of $(a^2 + x^2)^{-1}$ **8**

c) An airplane is flying on a horizontal path at a eight of *3800 ft*, as shown in the figure : 04. At what rate is the distance s between the airplane and the fixed point P changing with respect to θ when $\theta = 30°$? Express the answer in units of feet/degree. **10⅓**

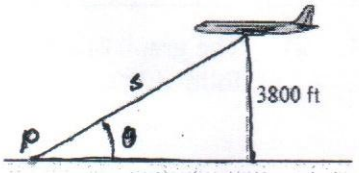

Figure: 04

3. a) If $y = \tan^{-1} x$ prove that $(1+x^2)y_2 + 2xy_1 = 0$ and deduce that $(1+x^2)y_{n+2} + 2(n+1)xy_{n+1} + n(n+1)y_n = 0$ hence determine $(y_n)_0$ **8⅓**

b) A rocket, rising vertically, is tracked by a radar station that is on the ground 5 mi from the Launchpad. How fast is the rocket rising when it is 4 mi high and its distance from the radar station is increasing at a rate of 2000 mi/h? **10**

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. **15**

4. a) A drainage channel is to be made so that its cross section is a trapezoid with equally sloping sides (Shown in Figure: 05). If the sides and bottom all have a length of 5 ft, how should the angle θ $(0 \le \theta \le \pi/2)$ be chosen to yield the greatest Cross-sectional area of the channel? **15**

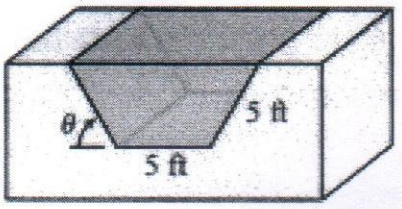

Figure: 05

b) Sketch the graph of the equation $y = \dfrac{2(x^2 - 9)}{x^2 - 4}$ and identify the locations of the intercepts, relative extrema, inflection points and asymptotes. **18⅓**

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B Sc Engg. (MCE), 1st Sem — 15 March, 2018 (Afternoon)

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

MID TERM EXAMINATION — WINTER SEMESTER 2017 -2018
Course No: Chem- 4115 — Time : 1.5 hours
Course title: Physical and Inorganic Chemistry — Full Marks: 75

There are **Four** questions. Answer any **Three**
Marks in the margin indicate full marks

Q.1 a) Define Colligative properties. Why are they so called? Name them. **6**

b) Deduce an expression relating the molecular weight of a solute with the lowering of vapour pressure of a dilute solution. Define vapour pressure and boiling point. **10**

c) 36.4 gm urea is dissolved in 200gm of water at 50^0C. The lowering of vapour pressure is 15mm of Hg. Calculate the molecular weight (MW) of urea when the vapour pressure of water at 50^0C is 92mm of Hg. **9**

Q.2 a) State and discuss Henry's law in the dissolution of gases in liquids. Show the effect of temperature on dissolution of gases in liquid through equation. **8**

b) Show the importance of Critical Solution Temperature(CST) in the dissolution of liquid in liquid. Draw and explain CST diagram of Triethylamine- water system. **9**

c) Determine the molarity(M) of a solution containing 86.53g of Na_2CO_3 per litre of the solution in water at 20^0C. The density of the solution at this temperature is 1.0816gm.ml^{-1}. Calculate also the molality(m) of the solution. **8**

Q.3 a) State and explain Le Chatelier's principle with suitable examples. **6**

b) Derive the expression of Kp and Kc for the reaction $N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$ in terms of "a", "b" and "x" where "a" and "b" are initial number of moles of the reactants and"x" is the number of moles going into reaction at equilibrium. Let P and V are the total Pressure and volume of the system. Give the significance of the obtained expressions. **11**

c) For the reaction $PCl_5(g) \leftrightarrow PCl_3(g) + Cl_2(g)$, 35% $PCl_5(g)$ is dissociated at 100^0C. If the total pressure is 1.5atm, calculate the value of Kp and Kc. **8**

Q.4 Write short notes on the following : **5x5**

a) Units of concentration
b) Relationship between Kp and Kc
c) Classification of solutions with examples
d) Mechanism of dissolution of NaCl in water
e) Osmosis, osmotic pressure and reverse osmosis

B.Sc. Eng. (EE) 1st Semester — 16 March 2018 (Morning)

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

Mid Semester Examination — Winter Semester, A.Y. 2017-2018
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) State first law of thermodynamic. Prove that at constant temperature $\mathbf{d}H = q_p$. 9

b) What are the factors affecting the ionization energy? Explain them elaborately. 10

c) Calculate the standard heat of formation of propane (C_3H_8) if its heat of combustion is – 2220.2 kJ mol^{-1}. The heats of formation of $CO_2(g)$ and $H_2O(l)$ are – 393.5 and – 285.8 kJ mol^{-1}, respectively. 6

2 a) What is hybridization? Explain different types of hybridization likes sp, sp^2, sp^3, dsp^3 and d^2sp^3 hybridization. What would be the shape of molecules for the above stated hybridization? Explains with suitable examples. 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 CO 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 uncertainty principle. Draw the shape of p- and d-oribitals. 8

c) Calculate the wavelength and energy of the emitted photon for the second line of the Lyman series of the hydrogen atom emission spectra. 7

4 a) State and explain Raoult's Law. Show that lowering of vapour pressure of a solution by the addition of nonvolatile solute is a colligative property. 8

b) 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. 10

c) Safrole is contained in oil of sassafras and was once used to flavor root beer. A 2.39 mg sample of safrole was dissolved in 103.0 mg of diphenyl ether. The solution had a melting point of 25.70°C. Calculate the molecular mass of safrole. The freezing point of pure diphenyl ether is 26.84°C, and the freezing-point depression constant, K_f = is 8.0°C/*m*. 7

B.Sc. Eng. (CEE) 1st Semester — 15 March 2018 (Afternoon)

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

Mid Semester Examination — Winter Semester, A.Y. 2017-2018
Course Code: Chem 4153 — Time : 1.30 hours
Course Title: Chemistry-I — 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? Explains the reason of the above anomalies. 10

c) The heat of combustion of ethyl alcohol is – 330 kcal. If the heat of formation of $CO_2(g)$ and $H_2O(l)$ be – 94.3 kcal and – 68.5 kcal, respectively. Calculate the heat of formation of ethyl alcohol. 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 a covalent? What are the factors favouring the formation of covalent bond? 5

c) Describe bonding and antibonding molecular orbitals according to molecular orbital theory. With the aid of MOT describe whether NO is formed or not, and state their magnetic properties. 8

3 a) Derive an expression applying Bohr atom model for the calculation of energy and wavelength of radiation obtained in the emission of spectrum of hydrogen. 10

b) State and explains 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 wavelength and energy of the emitted photon for the third line of the Lyman series of the hydrogen atom emission spectra. 7

4 a) What is colligative property of a dilute solution? Derive an expression relating depression of freezing point of a solution and molar mass of solute with the help of vapour pressure- temperature diagram. 12

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

c) The formula for low-molecular-mass starch is $(C_6H_{10}O_5)n$, where n averages 2.00×10^2. When 0.798 g of starch is dissolved in 100.0 mL of water solution, what is the osmotic pressure at 25^0C? 7

10

B.Sc. Engg 3rd /HDME 3rd Sem **14 March 2018 (Morning)**

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

Mid Term Examination — Winter Semester: A.Y. 2017-2018
Course Code: MCE 4305 — Time : $1\frac{1}{2}$ Hours
Course Title : Basic Thermodynamics — Full Marks : 75

There are 4 (Four) Questions. Answer any 3 (Three) Questions.
****Answering of Question 1 is compulsory****
Figures in the right margin indicate full marks. Don't write on this question paper.
*Unnecessary/irrelevant writing will guarantee nothing but zero mark.
Do not waste your time on the questions that you have no idea on **

1. a) Show the constant volume process and constant pressure process at a particular temperature on a single T-S diagram. Which one has the higher slope? Explain with thermodynamic equation. 6

b) For the following processes, do the slopes in T-S diagram change with temperature? Explain with thermodynamic equation and T-S diagram. 6
(a) Constant Volume process
(b) Constant Pressure process

c) Certain quantity of air at a pressure of 1 bar and temperature 70 ^{0}C is compressed reversibly and adiabatically until the pressure is 7 bar in an Otto cycle engine. 460 kJ of heat per kg of air is now added at constant volume. Determine: 13
1. Compression ratio of the engine,
2. Temperature at the end of compression,
3. Temperature at the end of heat addition, and
4. Carnot/maximum efficiency of the cycle within the same extreme temperatures.

Take for air, Cp = 1 kJ/kg K and Cv = 0.707 kJ/kg K.

2. a) What is meant by steady flow? Write steady flow energy equation for a flow through a nozzle. 7

b) Air is expanded reversibly and adiabatically in a turbine from 3.5 bar and 260°C to 1 bar. The turbine is insulated and the inlet velocity is negligible. The exit velocity is 150 m/s. Find the work output of the turbine per unit mass of air flow. 14
Take for air, Cp= 1.005 kJ/kg K, Cp/Cv = 1.4.

c) "Carnot engine is 100% efficient". Is the statement true? Explain if it violates any of the first two laws of thermodynamics. 4

3. a) What are the limitations of First Law of thermodynamics? Show the equivalence between the Kelvin-Plank's and Clausius's statements of the second law of thermodynamics. 10

   b) What is meant by Quasi-static process? "Quasi-static processes and reversible processes are used interchangeably but they have a difference". Explain. 8

   c) Prove that Carnot engine is the most efficient engine within the same extreme temperatures. 7

4. a) Heat supplied in a closed system in a constant volume process is denoted as $Q=m\ Cv\ (T_2-T_1)$ where, Q=heat supplied, m=mass, Cv=specific heat at constant volume, and T_1, T_2=initial and final temperatures. 6
   From the energy equation applied to closed sytem and Joule's law , prove that change of internal energy is always given by $Q= m\ Cv\ (T_2-T_1)$

   b) Prove that energy is a point function of a system using First Law of Thermodynamics. 7

   c) In figure 01, the water in the tank is pressurized by air. Determine the gage pressure of air in the tank if $h_1 = 0.2$ m, $h_2 = 0.3$ m, and $h_3 = 0.46$ m. Take the densities of water, oil, and mercury to be 1000 kg/m^3, 850 kg/m^3, and 13,600 kg/m^3, respectively. The point 2 is exposed in the atmosphere. 12

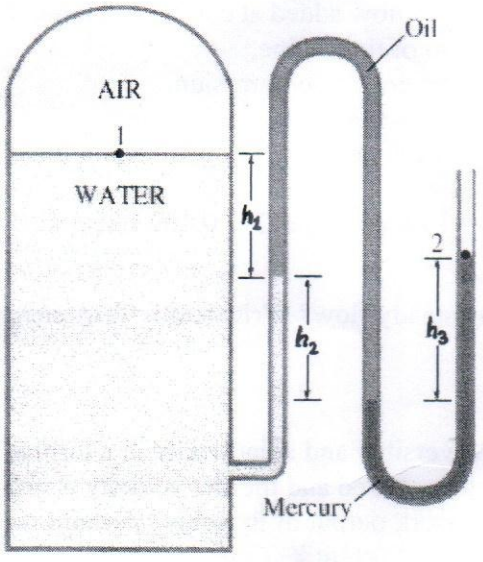

Figure 01

B. Sc.Engg., HDME/3rd Semester (MCE) 12 13 March 2018 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination — Winter Semester, A.Y. 2017-2018

Course Code: MCE 4311 — Time : 1½ hours

Course Title: Fluid Mechanics I — Full Marks : 100

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) What is *Viscosity*? Derive the expression for *Newton's Law of Viscosity* and based on the derivation, differentiate between Newtonian and Non-Newtonian fluid. **16**

   b) The viscosity of a fluid is to be measured by a viscometer constructed of two 40-cm-long concentric cylinders as shown in **Fig. 1**. The outer diameter of the inner cylinder is 12 cm, and the gap between the two cylinders is 0.15 cm. The inner cylinder is rotated at 300 rpm, and the torque is measured to be 1.8 N/m. Determine the viscosity of the fluid. **17.33**

2. a) What is *Hydrostatics* and *Aerostatics*? Derive an expression for the resultant hydrostatic force acting on a plane surface of a completely submerged plate in a homogeneousfluid and its centre of pressure. **16**

   b) Freshwater and seawater flowing in parallel horizontal Pipelines are connected to each other by a double U-tube manometer, as shown in **Fig. 2**. Determine the pressure difference between the two pipelines. Take the density of seawater at that location to be ρ=1035 kg/m^3. Can the air column be ignored in the analysis? **17.33**

3. a) What is *Conservation of Energy Principle*? Derive an expression for *Bernoulli's Equation* considering steady, incompressible flow where net frictional forces are negligible. **16**

   b) A horizontal pipeline is attached to the wall of reservoir as shown in **Fig. 3**. The pipeline has different profiles. The water level in the upper reservoir is in the height H = 1.5 m above 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 energy line (EL) and pressure line (PL). Resolve the problem neglecting losses. **17.33**

4. a) What is *Conservation of Mass Principle*? Derive an expression for *Continuity Equation* in 3D incompressible, steady flow. **16**

   b) A 10-cm fire hose with a 3-cm nozzle discharges water at 1.5 m^3/min to the atmosphere as shown in **Fig. 4**. Assuming frictionless flow, find the force F_B exerted by the flange bolts to hold the nozzle on the hose. **17.33**

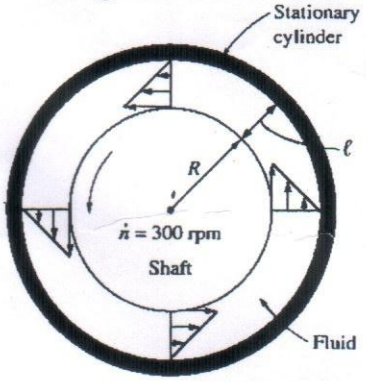

Fig: 1

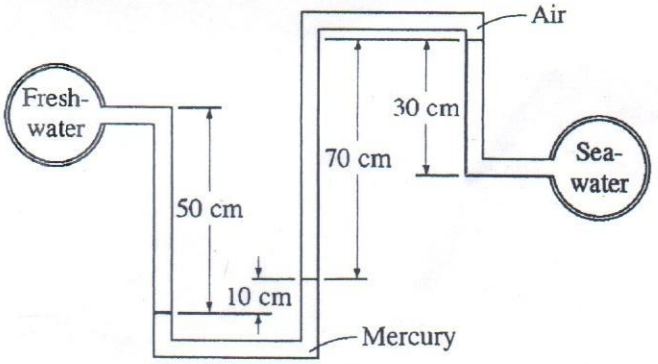

Fig: 2

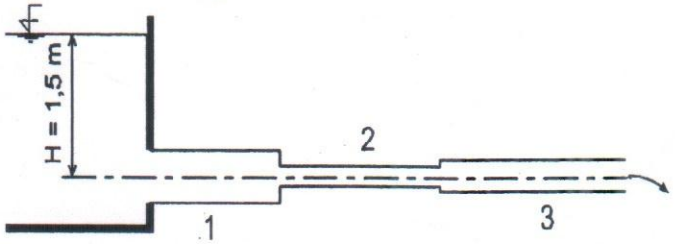

Fig: 3

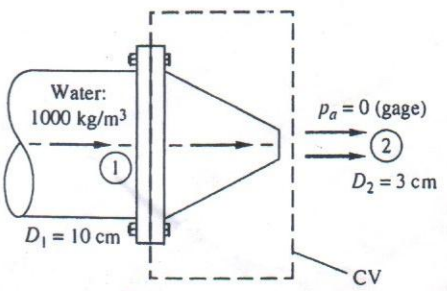

Fig: 4

B Sc. Eng./HDME(3rd Semester)/B Sc TE(2 Yr/1st Semester) 20 March 2018(Morning)

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

Mid Semester Examination — Winter Semester, A.Y. 2017-2018
Course Code: Math-4311/Math-4599 — Time : 1½ hours
Course Title: Vector Analysis — Full Marks : 75

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) (i) If $\bar{a} = 4\boldsymbol{i} + \boldsymbol{j} + \boldsymbol{k}$, $\bar{b} = 2\boldsymbol{i} + \boldsymbol{j} + 2\boldsymbol{k}$ *and* $\bar{c} = 3\boldsymbol{i} + 4\boldsymbol{j} + 5\boldsymbol{k}$, find $(\bar{a} + \bar{b}).(\bar{b} + c)$. **15**
   (ii) Determine λ such that $\bar{a} = i + j + k, \bar{b} = 2i - 4k$ *and* $\bar{c} = i + \lambda j + 3k$ are coplanar.
   b) Show that the three vectors **A**= **i**+2**j**+3**k**, **B** = 4**i**+5**j**+6**k** and **C** = 2**i**+**j** are linearly dependent. Determine a relation between them. **10**
2. a) The position of a moving particle at time t is given by **10**
   $$x = 4t + 3, y = t^2 + 3t, z = t^3 + 5t^2.$$
   Obtain (i) the velocity and acceleration of the particle.
   (ii) the magnitude of both velocity and acceleration at $t = 1$.
   b) (i) If $\overline{F} = 2u^2v\,i + (3u - v^3)\,j + (u^3 + 3v^2)\,k$, then find **15**
   $$\frac{\partial \overline{F}}{\partial u}, \frac{\partial \overline{F}}{\partial v}, \frac{\partial^2 \overline{F}}{\partial u^2}, \frac{\partial^2 \overline{F}}{\partial v^2}, \frac{\partial^2 \overline{F}}{\partial u\,\partial v}, \frac{\partial^2 \overline{F}}{\partial v\,\partial u}$$
   (ii) If $\overline{F} = (t^3 + 3t)i + 2t^2 j + (t - 4)k$, calculate $\int_0^1 \overline{F}\,dt$
3. a) Compute the directional derivative of $\phi = x^2z + 2xy^2 + yz^2$ at the point *(1, 2, -1)* in the direction of the vector $\overline{A} = 2i + 3j - 4k$. **10**
   b) (i) If $\overline{A} = x^2y\,i - xyzj + yz^2k$, determine $div\,\overline{A}$ at the point (1, 2, 3). **15**
   (ii) If $\overline{A} = (y^4 - x^2z^2)i + (x^2 + y^2)\,j - x^2yz\,k$, determine $curl\,\overline{A}$ at the point (1, 3, -2).
4. a) If $V = xy^2z$ and a curve C is given by $x = 3u$, $y = 2u^2$, $z = u^3$, then find $\int_C V dr$ along C **10**
   from A = (0, 0, 0), to B = (3, 2, 1).
   b) (i) Show that $\bar{F} = (siny + z)i + (xcosy - z)j + (x - y)k$ is irrotational. **15**
   (ii) Show that $\bar{F} = 3yz^2i + 4x^3z^2j - 3x^2y^2k$ is solenoidal.

----END----

14

B.Sc. Engg. (ME)/HDME (3rd Sem) **19 March 2018 (Morning)**

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

Mid Semester Examination — Winter Semester, A.Y. 2017-2018
Course Code: MCE 4321 — Time : 1½ hours
Course Title: Manufacturing Process — Full Marks : 100

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

1.	a)	What is manufacturing process? Broadly classify the different engineering manufacturing processes.	10
	b)	What is sheet metal processes? Classify the different sheet metal working processes and explain briefly the different sheet metal processes?	15
	c)	Write down the differences in between cold working and hot working processes?	8.33
2.	a)	Write a short note with neat sketches on explosive forming and wire drawing process.	10
	b)	Explain with neat sketches the open die hammering forging processes and write down its difference with Impression die forging processes.	15
	c)	Write down the difference in between the tandem rolling mill and four high rolling mill?.	8.33
3.	a)	Explain with necessary diagram the different methods for holding the work-piece in a lathe machine.	12
	b)	List the different types of lathe machine and write down the constructional details with schematic illustration of a center lathe.	15
	c)	How a lathe machine is specified?	6.33
4	a)	Explain the differences in between the radial drill and gang drilling machine?	13
	b)	Write a short note on Counter boring and counter sinking operation.	10
	c)	Explain with necessary diagram the quick return mechanism using straight gears and rack method.	10.33

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

March 13, 2018 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

MID SEMESTER EXAMINATION
COURSE NO: MCE 4503
COURSE TITLE: MECHANICS OF MACHINES

WINTER SEMESTER: 2017-2018
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) What do you mean by Kinematic Link? Write down the difference between a Machine and a Structure. (6)

   (b) Determine the Degrees of Freedom of the systems shown in Fig.1. From the number of degrees of freedom, write down the types of kinematic chain. (6)

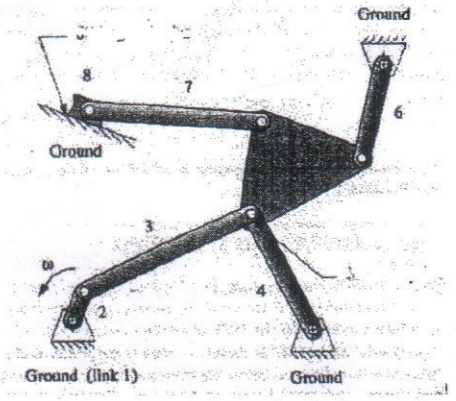


Fig. 1 (a)

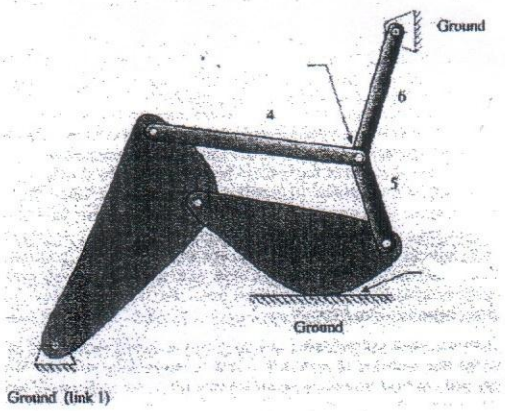


Fig. 1(b)

   (c) Prove that if all joints are full joints, an odd number of DOF requires an even number of links and vice versa. (6)

   (d) A link may be binary, ternary, quaternary, etc. Now, for one DOF and 6 number of links, determine the possibilities of combination of different types of links. (7)

2. (a) Explain briefly with neat sketches the whitworth quick return motion mechanism. (12)

   (b) The lengths of various links of a mechanism shown in Fig.2 are: OA=0.3 m; AB=1m; CD=0.8 m; and AC=CB. Determine, for the given configuration, the velocity of the slider D if the crank OA rotates at 60 rpm in the clockwise direction. Also determine the angular velocity of the link CD. Use instantaneous center method. (13)

3. Figure 3 shows a mechanism in which the crank *OA*, 100 mm long rotates clockwise about *O* at 130 rpm. The connecting rod *AB* is 400 mm long. The rod *CE*, 350 mm long, is attached to *AB* at *C*, 150 mm from *A*. This rod slides in a slot in a trunnion at *D*. The end *E* is connected by a link *EF*, 300 mm long, to the horizontally moving slider *F*. Determine, for the given configuration: i) Velocity of *F*; ii) Velocity of sliding of *CE* in the trunnion ; and iii) Angular velocity of *CE*. Use relative velocity method. (25)

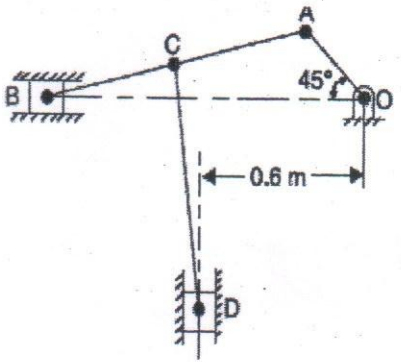


Fig. 2

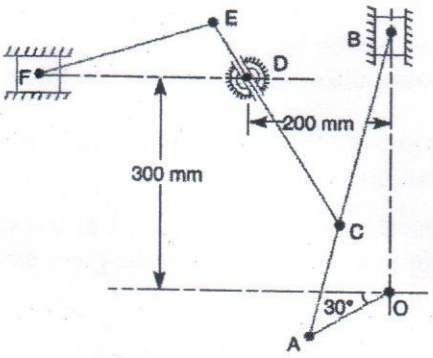


Fig. 3

4. The mechanism of a warping machine shown in Fig.4, has the dimensions as follows: O_1A=100 mm; AC=700 mm; BC= 200 mm; BD=150 mm; O_2D=200 mm; O_2E=400 mm; O_3C=200 mm. The crank O_1A rotates at a uniform speed of 100 rad/s. For the given configuration, determine: i) Linear velocity of the point E on the bell crank lever; ii) Acceleration of the points *E* and *B*; and iii) Angular acceleration of the bell crank lever. (25)

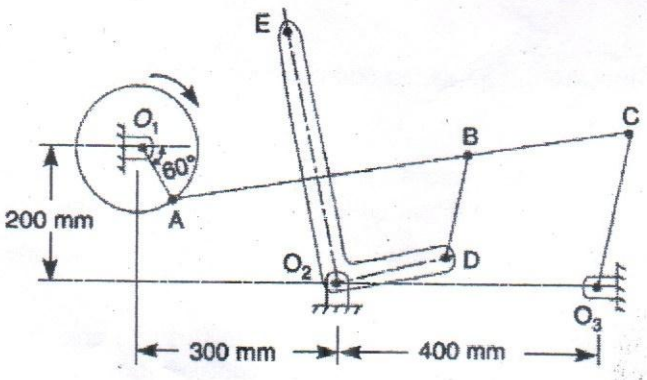


Fig. 4

BSc. Eng. (M)/ HDME/ 5th Sem. 17
BScTE(2-Yr) 1st Sem 15 March 2018(Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination — Winter Semester A.Y. 2017-2018
Course Code: MCE 4507/MCE 4593 — Time : 1.5 hours
Course Title: **Control system and Automation** — Full Marks : 50

There are **4 (Four)** Questions. Answer any **3(Three)** of them.
Assume reasonable data if necessary.
Programmable calculators are not allowed. Don't write on this question paper.

---

1. a) In the past, control systems used a human operator as part of a closed-loop control system. Sketch the block diagram of the valve control system shown in Figure 1. $(8\frac{2}{3})$

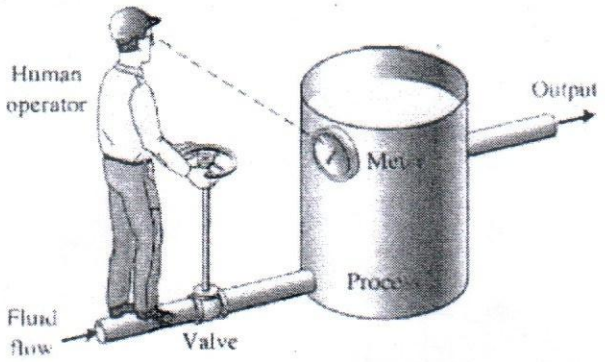


Figure 1: Fluid-flow control.

c) A precise optical signal source can control the output power level to within 1 percent. A laser is controlled by an input current to yield the power output. A microprocessor controls the input current to the laser. The microprocessor compares the desired power level with a measured signal proportional to the laser power output obtained from a sensor. Sketch the block diagram representing this closed-loop control system, identifying the output, input, and measured variables and the control device. (8)

2. a) What do you understand by **control system?** With examples, discuss the classification of **Control system.** $(6\frac{2}{3})$

b) Briefly discuss the following terms(any six) (10)

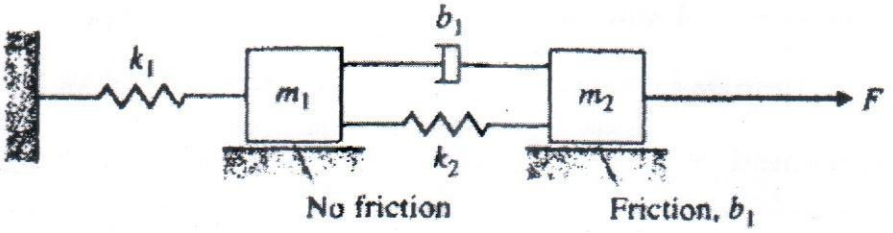
i) Feedback
ii) Input
iii) Output
iv) Control action
v) Plant
vi) Control signal
vii) Actuating error signal
viii) Primary feedback signal
ix) Controlled variable
x) Servomechanism

3. Obtain the solution of following problem using Laplace transformation $(16\frac{2}{3})$

$$10\frac{d^3x}{dt^3} + 100\frac{d^2x}{dt^2} + 310\frac{dx}{dt} + 300x = 750u(t)$$

$x(0)=2,\ \dot{x}(0) = 4,\ \ddot{x}(0) = 3$

4. Find the transfer function , $X_1(s)/F(s)$ and $X_2(s)/F(s)$ for the system of following figure $(16\frac{2}{3})$



Laplace transform table

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

Laplace transform theorems

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

BSc. Eng. (M)/ HDME/ 5th Sem. 19
BScTE(2-Yr) 1st Sem 15 March 2018(Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination — Winter Semester A.Y. 2017-2018
Course Code: MCE 4507/MCE 4593 — Time : 1.5 hours
Course Title: **Control system and Automation** — Full Marks : 50

There are **4 (Four)** Questions. Answer any **3(Three)** of them.
Assume reasonable data if necessary.
Programmable calculators are not allowed. Don't write on this question paper.

---

1. a) In the past, control systems used a human operator as part of a closed-loop control system. Sketch the block diagram of the valve control system shown in Figure 1. $(8\frac{2}{3})$

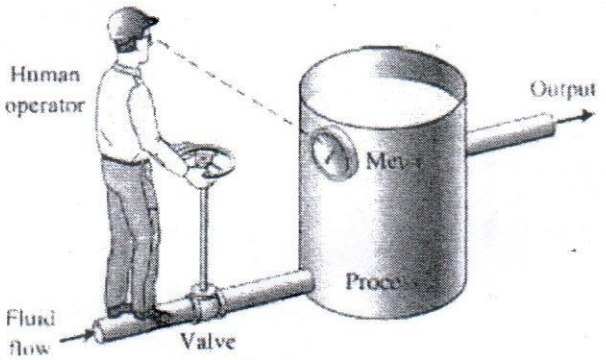


Figure 1: Fluid-flow control.

c) A precise optical signal source can control the output power level to within 1 percent. A laser is controlled by an input current to yield the power output. A microprocessor controls the input current to the laser. The microprocessor compares the desired power level with a measured signal proportional to the laser power output obtained from a sensor. Sketch the block diagram representing this closed-loop control system, identifying the output, input, and measured variables and the control device. (8)

2. a) What do you understand by **control system?** With examples, discuss the classification of **Control system**. $(6\frac{2}{3})$

b) Briefly discuss the following terms(any six) (10)

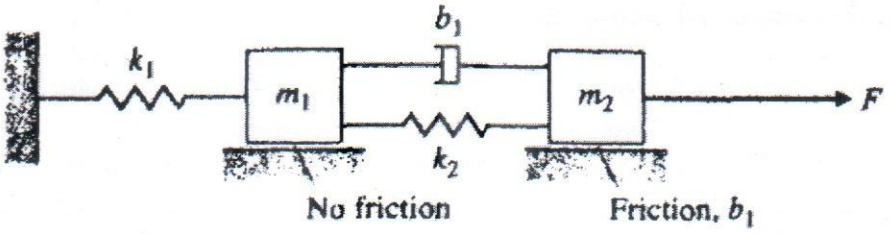
i) Feedback
ii) Input
iii) Output
iv) Control action
v) Plant
vi) Control signal
vii) Actuating error signal
viii) Primary feedback signal
ix) Controlled variable
x) Servomechanism

3. Obtain the solution of following problem using Laplace transformation $(16\frac{2}{3})$

$$10\frac{d^3x}{dt^3} + 100\frac{d^2x}{dt^2} + 310\frac{dx}{dt} + 300x = 750u(t)$$

$x(0)=2,\ \dot{x}(0) = 4,\ \ddot{x}(0) = 3$

4. Find the transfer function , $X_1(s)/F(s)$ and $X_2(s)/F(s)$ for the system of following figure $(16\frac{2}{3})$



Laplace transform table

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

Laplace transform theorems

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

B.Sc. Engg. (M)/ 5th Sem. 21 March 14,2018 (Morning)
HDME/ 5th Sem, BScTE/1st Sem

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

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

Winter Semester, A. Y. 2017-2018
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) Explain the construction and working principle of a centrifugal pump with the aid of a neat sketch. 10

   b) A jet of water of 5cm diameter with a velocity of 20m/s strikes a fixed plate in such a way that the angle between the jet and the pipe is 60°. Find the force exerted by the jet on the plate: (i) in the direction normal to the plate, (ii) in the direction of jet. 15

2. a) Briefly explain the following terms: 15
   1. Cavitation
   2. NPSH
   3. Priming

   b) Find the force exerted and work done by a jet on a moving curved vane, when the jet strikes the vane at its one end tangentially. 10

3. a) What is specific speed? Find an equation for the specific speed of a centrifugal pump. 10

   b) The external and internal diameters of an impeller of a centrifugal pump are 450 mm and 225 mm respectively. The pump delivers 200 l/s water at speed of 1250 rpm. The outside and inside widths of the impeller are 70mm and 150 mm. The vanes are curved backward at an angle of 30° at exit. If the manometric efficiency is 82%, find the work done per sec and manometric head. Water enters the impeller radially. 15

4. a) Derive an expression for energy conversion in the impeller of a centrifugal pump. 15

   b) Water is to be pumped out of a deep well under a total head of 156 cm. There are a number of identical pumps of design speed of 20 with a rated capacity of 150 liters/sec.Find the number of pumps required. 10

B.Sc. Engg. (M)/HDME/ 5th Sem 22 20 March 2018 (Morning)

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination — Winter Semester, A. Y. 2017-18
Course No Math 4511 — Time: 1.5 Hours
Course Title: Statistics and Quality Control — Full Marks: 75

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

Figures in the right 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. Raw data on strength of certain material is tabled below: [25]

215	147	296	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	139	205

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

2. a) Unplanned shutdown is a chronic problem in factories. In a manufacturing plant, after much discussion, consensus reached to the points that 'Oil leakage' and 'Human errors' as the primary causes. A diagnostic approach based on the fact was introduced. The table provides data on the causes of previous shutdowns: [16]

Causes	*Frequency*
Oil leakage	45
Human error	16
Cooling failure	65
Initiator System	25
Interlock malfunction	19
Heat Exchanger error	12

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

b) What is the probability of guessing correctly exactly 4 answers on a true-false examination paper that has 9 questions? [3]

c) Automobiles arrive at Gazni Bridge Toll Collection Point at the rate of 5 vehicles per minute on average. What is the probability that no automobiles arrive in a particular minute? What is the probability that more than 2 automobile arrives in a particular minute? [6]

3. a) GCE dept has 3 Professors, 5 Senior Lecturers and 7 Lecturers. The Head of GCE dept has decided that he will make a 'three members Syllabus Review Committee' by lottery. In the lottery, replacement is not allowed. What is the probability that the committee will be composed of only Non-Professors? What is the possibility that there will be atleast 2 Professors in the committee? [8]

b) A manufacturer of window frames knows from long experience that 5 percent of the production will have some type of minor defect that will require an adjustment. What is the probability that in a sample of 20 window frames more than two will need adjustment? What is the probability 2 or 3 or 4 will need adjustment? [8]

c) Draw a cause and effect(Ishikawa) diagram for the large no of faulty air conditioners produced by your air-conditioner manufacturing company [6]

4. a) KP Pipes Ltd. Produces steel pipes 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 cm) 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 March and the findings are shown in the table. From this table, draw the X-bar and R chart and comment. [15]

Day	Average diameter of the sample(cm)	Range, R
1	10.745	0.040
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	10.769	0.042

b) Suppose samples of 212 cards are taken form a keypunch operation at 2 hour intervals to quality control of the keypunch process. The percentage of cards in error for the past 9 samples is found to be 0.8%, 1.2%, 1.6%, 2%, 2.5%, 1.8%, 1.4%, 0.9% and 1.3%. Find out the p chart that should include CL, UCL and LCL and comment on the findings. [10]

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

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

$$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

$$LCL = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

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

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

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

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

Median

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

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

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March 16, 2018 (Morning)

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination
Course No.: MCE 4521
Course Title: Materials Engineering

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

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

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

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1. (a) Draw the iron and iron carbide thermal equilibrium diagram labelling all points, lines and phase fields. (15)

   (b) Describe the microstructural changes that occur in a low carbon steel containing 0.2% carbon during slow cooling from austenite range. (07)

   (c) Mention the effect of carbon content on the yield strength, hardness and toughness of plain carbon steel. (03)

2. (a) Distinguish between annealing and normalizing. "Normalized mild steel shows finer grain size than annealed mild steel." Explain in detail how the grain size becomes finer in normalized steel. (15)

   (b) Draw the microstructure of a mild steel rod both in the annealed and normalized conditions. Which steel is stronger and why? (10)

3. (a) What is martensite? Give an outline of the formation of martensite. What is meant by the terms M_s and M_f? Mention four important quenching media. (10)

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

4. (a) "Hardening a high carbon steel part by quenching is almost always immediately followed by tempering" - why? (7)

   (b) Describe the effect of tempering temperature on the hardness, toughness, residul stress and microstructure of a quenched high carbon steel part. (18)

B.Sc. Eng. (CSE)/ 5th Sem. 13 March, 2018 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

TERM : Mid Semester Examination Winter Semester: 2017-2018

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) Show that the function $f(z) = u + iv$, where **13**

$$f(z)=\begin{cases}\dfrac{x^3(1+i)-y^3(1-i)}{x^2+y^2}; & z\neq 0\\ 0 \qquad\qquad\qquad\quad ; & z=0\end{cases}$$

satisfies the Cauchy-Riemann equations at $z = 0$. Is the function analytic at $z = 0$? Justify your answer.

b) Define a harmonic function and conjugate harmonic function. Are the following function harmonic? If your answer is yes, find a corresponding analytic function $f(z) = u(x,y) + iv(x,y)$. **12**

$$u=\frac{x}{x^2+y^2}$$

2. a) (i) Find the following functions in the form of $u + iv$ **8**

$$e^{2+3\pi i} \text{ and } \cosh(-1+2i)$$

(ii) Find all solutions and graph in the complex plane **8**

$$e^{z=1} \text{ and } \sinh z = 0$$

b) Evaluate $\int_C (z-z^2)dz$ where C is the upper half of the circle $|z - 2| = 3$ and z is the complex variable. What is the value of the integral if C is the lower half of the above given circle? **9**

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) Evaluate, using Cauchy's integral formula, **12**

(*i*) $\int_c \frac{3z^2+z}{z^2-1}dz$, If c is circle $|z-1|=1$.

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

4. a) (i) $z_n = \frac{n\pi}{4+2ni}$ is a sequence. Is it bounded? Convergent? Find its limit points. **5**

(ii) What is radius of convergence? Write its role in complex series. Find the center and radius of converges of the following series: $\sum_{n=0}^{\infty} \frac{(2n)!}{4^n(n!)^2}(z-2i)^n$ **8**

b) Find the Taylor series with center z_o and its radius of convergence. **12**

(i) $\frac{1}{1-z}, z_o = i$, (*ii*) $\sin 2z^2, z_o = 0$

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

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March 19, 2018 (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. 2017-2018
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.

---

1. a) Why CAD, CAE and CAM is required? Describe the steps for CAD and CAE in the design process of a product cycle. 15

   b) Describe the following drawing functions with figures: 10
   (i) Spline *(ii)* Offset entities *(iii)* Fillet and Chamfer *(iv)* Linear sketch pattern *(v)* Circular sketch pattern

2. a) An object in space is rotated by 90 degrees about an axis that is parallel to the x axis of the world coordinate system and passes through a point having world coordinates (0, 2, 1). If a point on the object has model coordinates (1, 1, 2), what will be the world coordinates of the same point after the rotation? 15

   b) Explain why, in order to use a single matrix to represent the affine transformation, a point must be represented by homogeneous coordinates $[x\ y\ z\ 1]^T$ rather than the conventional $[x\ y\ z]^T$. 10

3. a) What is Oct-tree representation? How is it computed? Explain why the octree representation requires less memory space than the voxel repetition for the same resolution. 15

   b) Establish the relationship between V, E, F, H, P, and W using Euler-Poincare formula for the Figure 1. Where, V be the number of vertices, E the number of Edges, F the number of Faces, H the number of hole inner loops, P the number of through holes and W be the number of voids in the solid (The small cube is a hollow part, also called a void) 10

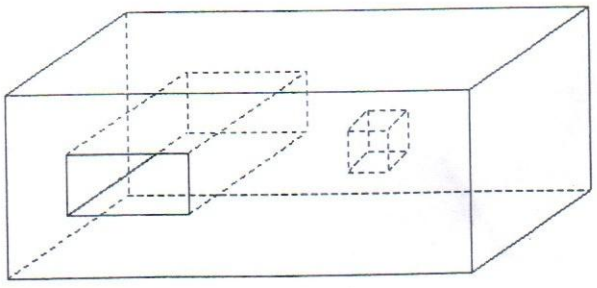

Figure 1

4. a) Given two 3D points $\mathbf{P_0}$, $\mathbf{P_1}$ and their respective tangent vectors $\mathbf{P_0'}$ and $\mathbf{P_1'}$. Find a cubic curve to interpolate them. Explain what will happen if you choose a quadric curve for interpolation. 20

   b) What are the different types of continuity of a curve? 5

B.Sc. Engg. (M)/ HDME -5th Sem./ /DTE 1st Sem 19 March 2018 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

MID SEMESTER EXAMINATION WINTER SEMESTER: 2017-2018

Course No: MCE-4551 TIME : 1HR 30 MINS

Course Name: Refrigeration FULL MARKS: 75

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) 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.

   (b) A refrigerator operates on a reversed Carnot cycle with a maximum temperature of **50^0C** and minimum temperature of **0^0C**. The machine produces **15 kW** of cooling. Find **COP** of refrigeration, **COP** of heat pump, net wokdone and heat rejected.

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

   (b) **Refrigerant-134a** enters the compressor of a refrigerator as superheated vapor at **0.14 MPa** and **10^0C** at a rate of **0.05 kg/s** and leaves at **0.8 MPa** and **50^0C**. The refrigerant is cooled in the condenser to **26^0C** and **0.72 MPa** and is throttled to **0.15 MPa**. Disregarding any heat transfer and pressure drops in the connecting lines between the components, determine

   (i) the rate of heat removal from the refrigerated space and the power input to the compressor,
   (ii) the isentropic efficiency of the compressor, and
   (iii) the coefficient of performance of the refrigerator.

   Draw cycle on P-h diagram.

3. 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-

(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, **°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.

4. (a) Draw the refrigeration system with heat exchanger and explain with necessary diagrams how it helps to increase the refrigerating effect.

"However the use of heat exchanger may have negligible thermodynamic advantages"- Justify this statement.

(b) A heat pump with **refrigerant-134a** as the working fluid is used to keep a space at **25^0C** by absorbing heat from geothermal water that enters the evaporator at **50^0C** at a rate of **0.065 kg/s** and leaves at **40^0C**. The refrigerant enters the evaporator at **20^0C** 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 –

(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.

Draw cycle on P-h diagram.

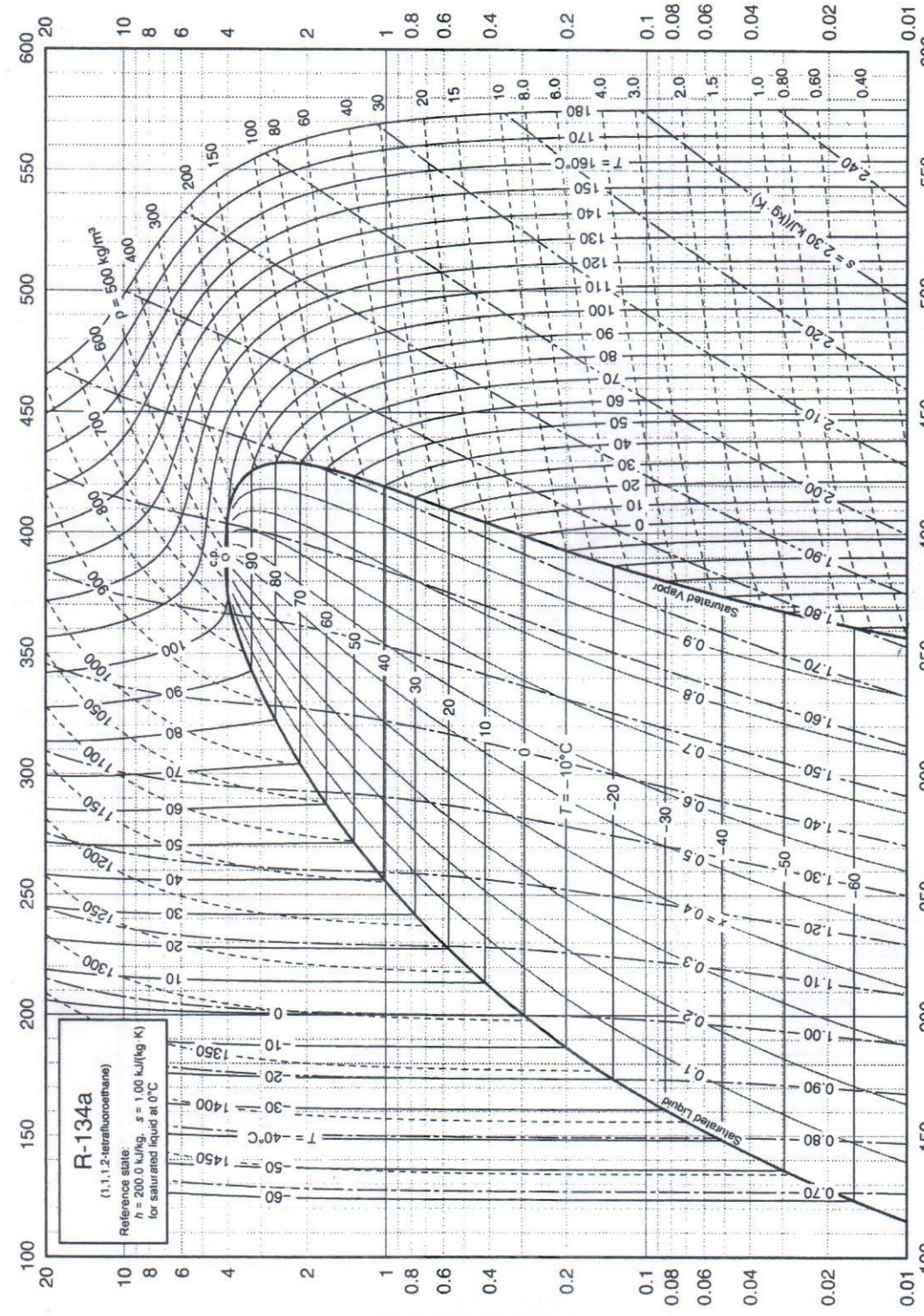

Fig. 8 Pressure-Enthalpy Diagram for Refrigerant 134a

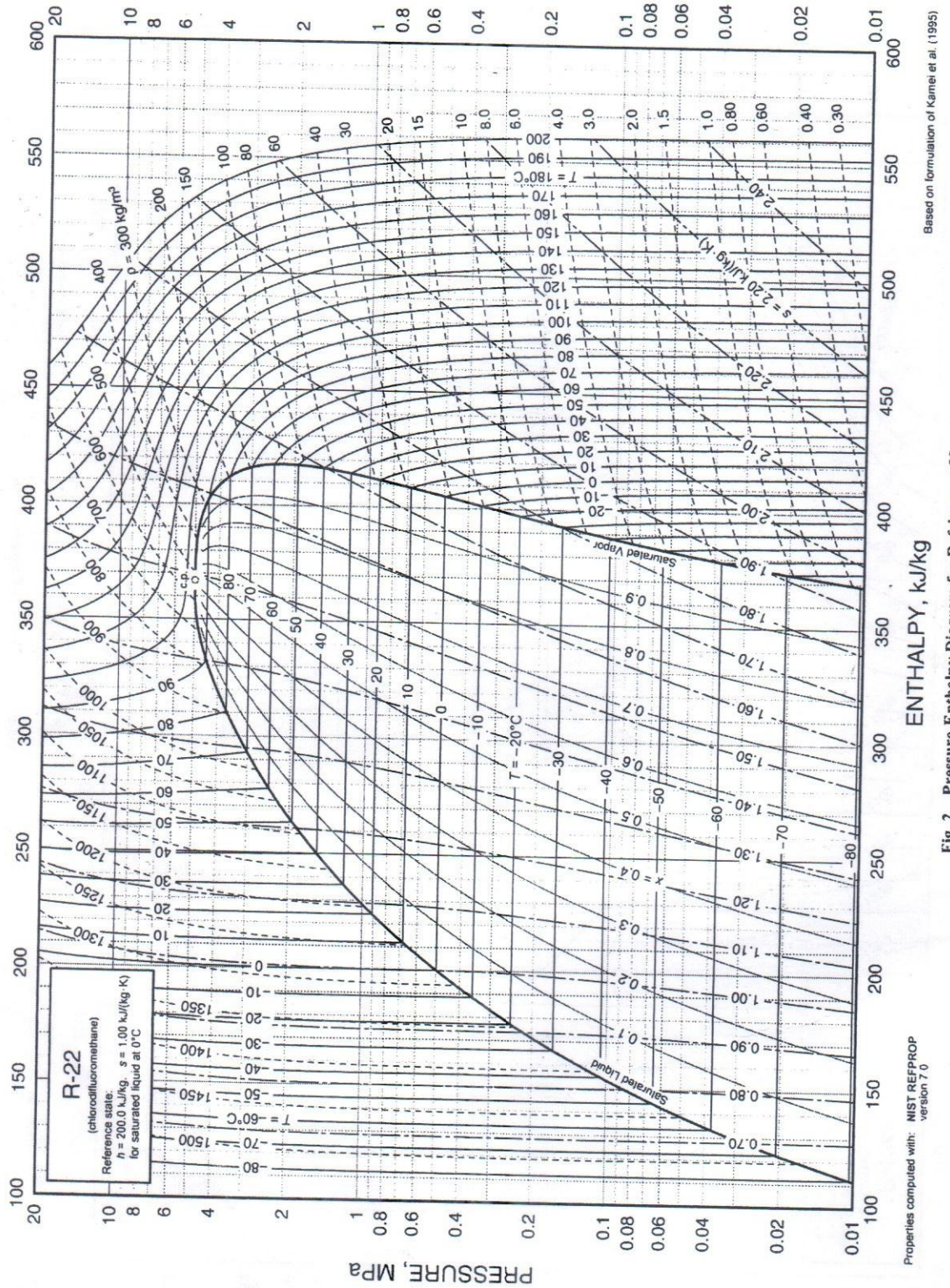

Fig. 2 Pressure-Enthalpy Diagram for Refrigerant 22

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

Mid Semester Examination — Winter Semester, A.Y. 2017-2018
Course Code: MCE 4573 — Time : 1.5 hours
Course Title: Renewable Energy Resources — Full Marks : 75

There are **4 (four)** Questions. Answer any **3 (three)** of them.
Marks in the Margin indicate the full marks. The symbols have their usual meaning.

1. a) Compare the conventional and renewable energy sources. 6

   b) Write down the principal characteristics of the sun and draw its structural composition. 9

   c) What is the solar time corresponding to 9:00 AM central time on February 7 for a place of longitude 89.4°? The standard meridian is 90°. 10

2. a) With the help of neat sketches discuss zenith angle, solar azimuth angle and hour angle. 12

   b) Calculate the zenith and solar azimuth angles for the latitude 43° at 6:30 PM on August 11. 13

3. a) Write short notes on geothermal energy, wind energy and solar constant. 12

   b) Calculate R_b for a surface at latitude 40° N at a tilt 25° toward the south for the hour 9 to 10 solar time on June 16. 13

4. a) With the help of neat sketches describe any two instruments used for measuring solar radiation. 10

   b) The day's total radiation on a horizontal surface for St. Louis, Missouri (latitude 38.6°), on September 3 is 27.0 MJ/m^2. Estimate the fraction and amount that is diffuse. 15

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$$Solar\ time - standard\ time = 4(L_{st} - L_{loc}) + E$$

$$E = 229.2(0.000075 + 0.001868\cos B - 0.032077\sin B - 0.014615\cos 2B - 0.04089\sin 2B)$$

$$B = (n-1)\frac{360}{365}$$

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

$$\omega = (T - 12) \times 15°$$

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

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

$$R_b = \frac{\cos(\phi-\beta)\cos\delta\cos\omega + \sin(\phi-\beta)\sin\delta}{\cos\phi\cos\delta\cos\omega + \sin\phi\sin\delta}$$

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

$$H_0 = \frac{24\times 3600 G_{sc}}{\pi}\left(1 + 0.033\cos\frac{360n}{365}\right)\times\left(\cos\phi\cos\delta\sin\omega_s + \frac{\pi\omega_s}{180}\sin\phi\sin\delta\right)$$

$$K_T = \frac{H}{H_0}$$

For $\omega_s \le 81.4°$

$$\frac{H_d}{H} = \begin{cases} 1.0 - 0.2727K_T + 2.4495K_T^2 - 11.9514K_T^3 + 9.3879K_T^4 & for K_T < 0.715 \\ 0.143 & for\ K_T \ge 0.715 \end{cases}$$

For $\omega_s > 81.4°$

$$\frac{H_d}{H} = \begin{cases} 1.0 + 0.2832K_T - 2.5557K_T^2 + 0.8448K_T^3 & for K_T < 0.722 \\ 0.175 & for\ K_T \ge 0.722 \end{cases}$$

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HDME 5th Sem **16 March 2018 (Morning)**

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

Mid Semester Examination — Winter Semester : A.Y. 2017-2018
Course Code: MCE 4585 — TIME : $1\frac{1}{2}$ Hours
Course Title : Automotive Technology-I — Full Marks : 75

There are 4 (Four) Questions. Answer any 3 (Three) Questions.
Figures in the margin indicate full marks. Don't write on this question paper.

1. a) What do you understand by "over square" engine and "under square" engine? 05

b) What do you understand by "Inlet and Exhaust Valve Overlap" in automotive. Why is this needed? 08

c) Draw both the theoretical and actual Otto cycle used in petrol engine and explain all the strokes. 12

2. a) Briefly describe the following terms used in automotive engines. 12

i) Indicated horsepower
ii) Compression ratio
iii) Engine displacement

b) What is a dynamometer? What are the types of dynamometers? Describe an absorption type dynamometer with necessary diagram. 13

3. a) Explain both the compression rings and oil control ring of piston with necessary diagrams. 15

b) Describe "Cam Ground Piston" in detail. 10

4. a) Describe the primary functions of engine cooling system in brief. 06

b) Describe the following components of liquid cooling used in a car with necessary diagrams. 12

i. Radiator pressure cap
ii. Thermostat
iii. Anti-freeze mixture

c) Briefly describe the baffles and fins used in air-cooled system, with necessary diagrams. 07

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

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination — Winter Semester, A. Y. 2017-2018
Course No.: MCE 4587 — Time: 1 Hours 30 Min(s)
Course Title: Automotive Maintenance Engineering I — 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 the importance of automotive maintenance engineering in your own language. 5

   b) Mention the names of the automotive maintenance tools which are used frequently with short description. 15

   c) What is the function of a feeler gauge and piston ring expander? 5

2. a) Why lubrication system is important? Describe the steps to diagnosis the fault of the lubrication system. 15

   b) Write down the working principle of hydraulic braking system with diagram. 10

3. a) What do you understand by Engine tune up? Write down the tuning procedure step by step. 10

   b) What is Crankshaft Thumping? What are the causes behind that? 15

4. a) Briefly explain the governing factors that is responsible for a braking system? 10

   b) Write down the working principle of drum brake and disk brake with schematic diagram. 15

BSc. Eng. (M) 7th Sem. 16 March 2018(Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination — Winter Semester A.Y. 2017-2018
Course Code: MCE 4705 — Time : 1.5 hours
Course Title: **Thermodynamics-III** — Full Marks : 75

There are **4 (Four)** Questions. Answer any **3(Three)** of them.
Assume reasonable data if necessary.
Programmable calculators are not allowed. Don't write on this question paper.

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1. Gaseous CO_2 is contained in a vertical piston–cylinder assembly by a piston of mass 50 kg and having a face area of 0.01 m^2. The mass of the CO_2 is 4 g. The CO_2 initially occupies a volume of 0.005 m^3 and has a specific internal energy of 657 kJ/kg. The atmosphere exerts a pressure of 100 kPa on top of the piston. Heat transfer in the amount of 1.95 kJ occurs slowly from the CO_2 to the surroundings, and the volume of the CO_2 decreases to 0.0025m^3. The local acceleration of gravity is 9.81 m/s^2. For the CO_2, determine (25)
   (a) The pressure, in kPa
   (b) The final specific internal energy, in kJ/kg.

2. A gas within a piston–cylinder assembly undergoes a thermodynamic cycle consisting of three processes: (25)
   Process 1–2: Compression with pV= constant, from p_1 = 1 bar,
   V_1=2 m^3 to V_2=0.2 m^3, $U_2 - U_1$ =100 kJ.
   Process 2–3: Constant volume to $p_3=p_1$.
   Process 3–1: Constant-pressure and adiabatic process.
   There are no significant changes in kinetic or potential energy. Determine
   a) Net work of the cycle, in kJ, and
   b) Heat transfer for process 2–3, in kJ

3. a) A piston cylinder contains 0.1 kg of air at 100 kPa and 27°C that goes through a polytropic compression process with n=1.25 to a pressure of 250 kPa. Assume air as an ideal gas and constant specific heats, determine (12)
   a) Work done in the process
   b) What is the heat transfer for the process?

   b) A closed, rigid tank fitted with a paddle wheel contains 0.1 kg of air, initially at 300 K, 0.5 MPa. The paddle wheel stirs the air for 15 minutes, with the power input varying with time according to (13)
   $\dot{W} = -10t$
   Where, $\dot{W}$ is in watts and t is time, in minutes.
   The final temperature of the air is 1090 K. Assuming ideal gas behavior and constant specific heats for air(no table is required), determine for the air
   (a) The final pressure, in MPa
   (b) The work, in kJ, and
   (c) The heat transfer, in kJ

4. Steam flows at steady state through a horizontal tube having an inside diameter of 0.05 m. Steam enters the tube with a quality of 0.1, temperature of 36°C, and velocity of 10 m/s. Steam exits the tube at 9 bar as a saturated liquid. Determine (25)
   (a) The mass flow rate of the steam, in kg/hr.
   (b) The velocity of the steam at the exit, in m/s.
   (b) The rate of heat transfer, in kW, and its associated direction with respect to the steam.

TABLE A-2

Pressure Conversions:
1 bar = 0.1 MPa
= 10^2 kPa

Properties of Saturated Water (Liquid–Vapor): Temperature Table

Temp. °C	Press. bar	Specific Volume m^3/kg Sat. Liquid $v_f \times 10^3$	Specific Volume m^3/kg Sat. Vapor v_g	Internal Energy kJ/kg Sat. Liquid u_f	Internal Energy kJ/kg Sat. Vapor u_g	Enthalpy kJ/kg Sat. Liquid h_f	Enthalpy kJ/kg Evap. h_{fg}	Enthalpy kJ/kg Sat. Vapor h_g	Entropy kJ/kg · K Sat. Liquid s_f	Entropy kJ/kg · K Sat. Vapor s_g	Temp. °C
.01	0.00611	1.0002	206.136	0.00	2375.3	0.01	2501.3	2501.4	0.0000	9.1562	.01
4	0.00813	1.0001	157.232	16.77	2380.9	16.78	2491.9	2508.7	0.0610	9.0514	4
5	0.00872	1.0001	147.120	20.97	2382.3	20.98	2489.6	2510.6	0.0761	9.0257	5
6	0.00935	1.0001	137.734	25.19	2383.6	25.20	2487.2	2512.4	0.0912	9.0003	6
8	0.01072	1.0002	120.917	33.59	2386.4	33.60	2482.5	2516.1	0.1212	8.9501	8
10	0.01228	1.0004	106.379	42.00	2389.2	42.01	2477.7	2519.8	0.1510	8.9008	10
11	0.01312	1.0004	99.857	46.20	2390.5	46.20	2475.4	2521.6	0.1658	8.8765	11
12	0.01402	1.0005	93.784	50.41	2391.9	50.41	2473.0	2523.4	0.1806	8.8524	12
13	0.01497	1.0007	88.124	54.60	2393.3	54.60	2470.7	2525.3	0.1953	8.8285	13
14	0.01598	1.0008	82.848	58.79	2394.7	58.80	2468.3	2527.1	0.2099	8.8048	14
15	0.01705	1.0009	77.926	62.99	2396.1	62.99	2465.9	2528.9	0.2245	8.7814	15
16	0.01818	1.0011	73.333	67.18	2397.4	67.19	2463.6	2530.8	0.2390	8.7582	16
17	0.01938	1.0012	69.044	71.38	2398.8	71.38	2461.2	2532.6	0.2535	8.7351	17
18	0.02064	1.0014	65.038	75.57	2400.2	75.58	2458.8	2534.4	0.2679	8.7123	18
19	0.02198	1.0016	61.293	79.76	2401.6	79.77	2456.5	2536.2	0.2823	8.6897	19
20	0.02339	1.0018	57.791	83.95	2402.9	83.96	2454.1	2538.1	0.2966	8.6672	20
21	0.02487	1.0020	54.514	88.14	2404.3	88.14	2451.8	2539.9	0.3109	8.6450	21
22	0.02645	1.0022	51.447	92.32	2405.7	92.33	2449.4	2541.7	0.3251	8.6229	22
23	0.02810	1.0024	48.574	96.51	2407.0	96.52	2447.0	2543.5	0.3393	8.6011	23
24	0.02985	1.0027	45.883	100.70	2408.4	100.70	2444.7	2545.4	0.3534	8.5794	24
25	0.03169	1.0029	43.360	104.88	2409.8	104.89	2442.3	2547.2	0.3674	8.5580	25
26	0.03363	1.0032	40.994	109.06	2411.1	109.07	2439.9	2549.0	0.3814	8.5367	26
27	0.03567	1.0035	38.774	113.25	2412.5	113.25	2437.6	2550.8	0.3954	8.5156	27
28	0.03782	1.0037	36.690	117.42	2413.9	117.43	2435.2	2552.6	0.4093	8.4946	28
29	0.04008	1.0040	34.733	121.60	2415.2	121.61	2432.8	2554.5	0.4231	8.4739	29
30	0.04246	1.0043	32.894	125.78	2416.6	125.79	2430.5	2556.3	0.4369	8.4533	30
31	0.04496	1.0046	31.165	129.96	2418.0	129.97	2428.1	2558.1	0.4507	8.4329	31
32	0.04759	1.0050	29.540	134.14	2419.3	134.15	2425.7	2559.9	0.4644	8.4127	32
33	0.05034	1.0053	28.011	138.32	2420.7	138.33	2423.4	2561.7	0.4781	8.3927	33
34	0.05324	1.0056	26.571	142.50	2422.0	142.50	2421.0	2563.5	0.4917	8.3728	34
35	0.05628	1.0060	25.216	146.67	2423.4	146.68	2418.6	2565.3	0.5053	8.3531	35
36	0.05947	1.0063	23.940	150.85	2424.7	150.86	2416.2	2567.1	0.5188	8.3336	36
38	0.06632	1.0071	21.602	159.20	2427.4	159.21	2411.5	2570.7	0.5458	8.2950	38
40	0.07384	1.0078	19.523	167.56	2430.1	167.57	2406.7	2574.3	0.5725	8.2570	40
45	0.09593	1.0099	15.258	188.44	2436.8	188.45	2394.8	2583.2	0.6387	8.1648	45

v_f = (table value)/1000

H_2O

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TABLE A-2

(*Continued*)

Pressure Conversions:
1 bar = 0.1 MPa
= 10^2 kPa

H_2O

Temp. °C	Press. bar	Specific Volume m^3/kg		Internal Energy kJ/kg		Enthalpy kJ/kg			Entropy kJ/kg · K		Temp. °C
		Sat. Liquid $v_f \times 10^3$	Sat. Vapor v_g	Sat. Liquid u_f	Sat. Vapor u_g	Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Sat. Vapor s_g	
50	.1235	1.0121	12.032	209.32	2443.5	209.33	2382.7	2592.1	.7038	8.0763	50
55	.1576	1.0146	9.568	230.21	2450.1	230.23	2370.7	2600.9	.7679	7.9913	55
60	.1994	1.0172	7.671	251.11	2456.6	251.13	2358.5	2609.6	.8312	7.9096	60
65	.2503	1.0199	6.197	272.02	2463.1	272.06	2346.2	2618.3	.8935	7.8310	65
70	.3119	1.0228	5.042	292.95	2469.6	292.98	2333.8	2626.8	.9549	7.7553	70
75	.3858	1.0259	4.131	313.90	2475.9	313.93	2321.4	2635.3	1.0155	7.6824	75
80	.4739	1.0291	3.407	334.86	2482.2	334.91	2308.8	2643.7	1.0753	7.6122	80
85	.5783	1.0325	2.828	355.84	2488.4	355.90	2296.0	2651.9	1.1343	7.5445	85
90	.7014	1.0360	2.361	376.85	2494.5	376.92	2283.2	2660.1	1.1925	7.4791	90
95	.8455	1.0397	1.982	397.88	2500.6	397.96	2270.2	2668.1	1.2500	7.4159	95
100	1.014	1.0435	1.673	418.94	2506.5	419.04	2257.0	2676.1	1.3069	7.3549	100
110	1.433	1.0516	1.210	461.14	2518.1	461.30	2230.2	2691.5	1.4185	7.2387	110
120	1.985	1.0603	0.8919	503.50	2529.3	503.71	2202.6	2706.3	1.5276	7.1296	120
130	2.701	1.0697	0.6685	546.02	2539.9	546.31	2174.2	2720.5	1.6344	7.0269	130
140	3.613	1.0797	0.5089	588.74	2550.0	589.13	2144.7	2733.9	1.7391	6.9299	140
150	4.758	1.0905	0.3928	631.68	2559.5	632.20	2114.3	2746.5	1.8418	6.8379	150
160	6.178	1.1020	0.3071	674.86	2568.4	675.55	2082.6	2758.1	1.9427	6.7502	160
170	7.917	1.1143	0.2428	718.33	2576.5	719.21	2049.5	2768.7	2.0419	6.6663	170
180	10.02	1.1274	0.1941	762.09	2583.7	763.22	2015.0	2778.2	2.1396	6.5857	180
190	12.54	1.1414	0.1565	806.19	2590.0	807.62	1978.8	2786.4	2.2359	6.5079	190
200	15.54	1.1565	0.1274	850.65	2595.3	852.45	1940.7	2793.2	2.3309	6.4323	200
210	19.06	1.1726	0.1044	895.53	2599.5	897.76	1900.7	2798.5	2.4248	6.3585	210
220	23.18	1.1900	0.08619	940.87	2602.4	943.62	1858.5	2802.1	2.5178	6.2861	220
230	27.95	1.2088	0.07158	986.74	2603.9	990.12	1813.8	2804.0	2.6099	6.2146	230
240	33.44	1.2291	0.05976	1033.2	2604.0	1037.3	1766.5	2803.8	2.7015	6.1437	240
250	39.73	1.2512	0.05013	1080.4	2602.4	1085.4	1716.2	2801.5	2.7927	6.0730	250
260	46.88	1.2755	0.04221	1128.4	2599.0	1134.4	1662.5	2796.6	2.8838	6.0019	260
270	54.99	1.3023	0.03564	1177.4	2593.7	1184.5	1605.2	2789.7	2.9751	5.9301	270
280	64.12	1.3321	0.03017	1227.5	2586.1	1236.0	1543.6	2779.6	3.0668	5.8571	280
290	74.36	1.3656	0.02557	1278.9	2576.0	1289.1	1477.1	2766.2	3.1594	5.7821	290
300	85.81	1.4036	0.02167	1332.0	2563.0	1344.0	1404.9	2749.0	3.2534	5.7045	300
320	112.7	1.4988	0.01549	1444.6	2525.5	1461.5	1238.6	2700.1	3.4480	5.5362	320
340	145.9	1.6379	0.01080	1570.3	2464.6	1594.2	1027.9	2622.0	3.6594	5.3357	340
360	186.5	1.8925	0.006945	1725.2	2351.5	1760.5	720.5	2481.0	3.9147	5.0526	360
374.14	220.9	3.155	0.003155	2029.6	2029.6	2099.3	0	2099.3	4.4298	4.4298	374.14

v_f = (table value)/1000

TABLE A-3

Pressure Conversions:
1 bar = 0.1 MPa
= 10^2 kPa

Properties of Saturated Water (Liquid–Vapor): Pressure Table

		Specific Volume m^3/kg		Internal Energy kJ/kg		Enthalpy kJ/kg			Entropy kJ/kg · K		
Press. bar	Temp. °C	Sat. Liquid $v_f \times 10^3$	Sat. Vapor v_g	Sat. Liquid u_f	Sat. Vapor u_g	Sat. Liquid h_f	Evap. h_{fg}	Sat. Vapor h_g	Sat. Liquid s_f	Sat. Vapor s_g	Press. bar
0.04	28.96	1.0040	34.800	121.45	2415.2	121.46	2432.9	2554.4	0.4226	8.4746	0.04
0.06	36.16	1.0064	23.739	151.53	2425.0	151.53	2415.9	2567.4	0.5210	8.3304	0.06
0.08	41.51	1.0084	18.103	173.87	2432.2	173.88	2403.1	2577.0	0.5926	8.2287	0.08
0.10	45.81	1.0102	14.674	191.82	2437.9	191.83	2392.8	2584.7	0.6493	8.1502	0.10
0.20	60.06	1.0172	7.649	251.38	2456.7	251.40	2358.3	2609.7	0.8320	7.9085	0.20
0.30	69.10	1.0223	5.229	289.20	2468.4	289.23	2336.1	2625.3	0.9439	7.7686	0.30
0.40	75.87	1.0265	3.993	317.53	2477.0	317.58	2319.2	2636.8	1.0259	7.6700	0.40
0.50	81.33	1.0300	3.240	340.44	2483.9	340.49	2305.4	2645.9	1.0910	7.5939	0.50
0.60	85.94	1.0331	2.732	359.79	2489.6	359.86	2293.6	2653.5	1.1453	7.5320	0.60
0.70	89.95	1.0360	2.365	376.63	2494.5	376.70	2283.3	2660.0	1.1919	7.4797	0.70
0.80	93.50	1.0380	2.087	391.58	2498.8	391.66	2274.1	2665.8	1.2329	7.4346	0.80
0.90	96.71	1.0410	1.869	405.06	2502.6	405.15	2265.7	2670.9	1.2695	7.3949	0.90
1.00	99.63	1.0432	1.694	417.36	2506.1	417.46	2258.0	2675.5	1.3026	7.3594	1.00
1.50	111.4	1.0528	1.159	466.94	2519.7	467.11	2226.5	2693.6	1.4336	7.2233	1.50
2.00	120.2	1.0605	0.8857	504.49	2529.5	504.70	2201.9	2706.7	1.5301	7.1271	2.00
2.50	127.4	1.0672	0.7187	535.10	2537.2	535.37	2181.5	2716.9	1.6072	7.0527	2.50
3.00	133.6	1.0732	0.6058	561.15	2543.6	561.47	2163.8	2725.3	1.6718	6.9919	3.00
3.50	138.9	1.0786	0.5243	583.95	2546.9	584.33	2148.1	2732.4	1.7275	6.9405	3.50
4.00	143.6	1.0836	0.4625	604.31	2553.6	604.74	2133.8	2738.6	1.7766	6.8959	4.00
4.50	147.9	1.0882	0.4140	622.25	2557.6	623.25	2120.7	2743.9	1.8207	6.8565	4.50
5.00	151.9	1.0926	0.3749	639.68	2561.2	640.23	2108.5	2748.7	1.8607	6.8212	5.00
6.00	158.9	1.1006	0.3157	669.90	2567.4	670.56	2086.3	2756.8	1.9312	6.7600	6.00
7.00	165.0	1.1080	0.2729	696.44	2572.5	697.22	2066.3	2763.5	1.9922	6.7080	7.00
8.00	170.4	1.1148	0.2404	720.22	2576.8	721.11	2048.0	2769.1	2.0462	6.6628	8.00
9.00	175.4	1.1212	0.2150	741.83	2580.5	742.83	2031.1	2773.9	2.0946	6.6226	9.00
10.0	179.9	1.1273	0.1944	761.68	2583.6	762.81	2015.3	2778.1	2.1387	6.5863	10.0
15.0	198.3	1.1539	0.1318	843.16	2594.5	844.84	1947.3	2792.2	2.3150	6.4448	15.0
20.0	212.4	1.1767	0.09963	906.44	2600.3	908.79	1890.7	2799.5	2.4474	6.3409	20.0
25.0	224.0	1.1973	0.07998	959.11	2603.1	962.11	1841.0	2803.1	2.5547	6.2575	25.0
30.0	233.9	1.2165	0.06668	1004.8	2604.1	1008.4	1795.7	2804.2	2.6457	6.1869	30.0
35.0	242.6	1.2347	0.05707	1045.4	2603.7	1049.8	1753.7	2803.4	2.7253	6.1253	35.0
40.0	250.4	1.2522	0.04978	1082.3	2602.3	1087.3	1714.1	2801.4	2.7964	6.0701	40.0
45.0	257.5	1.2692	0.04406	1116.2	2600.1	1121.9	1676.4	2798.3	2.8610	6.0199	45.0
50.0	264.0	1.2859	0.03944	1147.8	2597.1	1154.2	1640.1	2794.3	2.9202	5.9734	50.0
60.0	275.6	1.3187	0.03244	1205.4	2589.7	1213.4	1571.0	2784.3	3.0267	5.8892	60.0
70.0	285.9	1.3513	0.02737	1257.6	2580.5	1267.0	1505.1	2772.1	3.1211	5.8133	70.0
80.0	295.1	1.3842	0.02352	1305.6	2569.8	1316.6	1441.3	2758.0	3.2068	5.7432	80.0
90.0	303.4	1.4178	0.02048	1350.5	2557.8	1363.3	1378.9	2742.1	3.2858	5.6772	90.0
100.	311.1	1.4524	0.01803	1393.0	2544.4	1407.6	1317.1	2724.7	3.3596	5.6141	100.
110.	318.2	1.4886	0.01599	1433.7	2529.8	1450.1	1255.5	2705.6	3.4295	5.5527	110.

v_f = (table value)/1000

H_2O

TABLE A-3

(*Continued*)

Pressure Conversions: 1 bar = 0.1 MPa = 10^2 kPa

H_2O

Press. bar	Temp. °C	Specific Volume m^3/kg Sat. Liquid $v_f \times 10^3$	Specific Volume m^3/kg Sat. Vapor v_g	Internal Energy kJ/kg Sat. Liquid u_f	Internal Energy kJ/kg Sat. Vapor u_g	Enthalpy kJ/kg Sat. Liquid h_f	Enthalpy kJ/kg Evap. h_{fg}	Enthalpy kJ/kg Sat. Vapor h_g	Entropy kJ/kg · K Sat. Liquid s_f	Entropy kJ/kg · K Sat. Vapor s_g	Press. bar
120.	324.8	1.5267	0.01426	1473.0	2513.7	1491.3	1193.6	2684.9	3.4962	5.4924	120.
130.	330.9	1.5671	0.01278	1511.1	2496.1	1531.5	1130.7	2662.2	3.5606	5.4323	130.
140.	336.8	1.6107	0.01149	1548.6	2476.8	1571.1	1066.5	2637.6	3.6232	5.3717	140.
150.	342.2	1.6581	0.01034	1585.6	2455.5	1610.5	1000.0	2610.5	3.6848	5.3098	150.
160.	347.4	1.7107	0.009306	1622.7	2431.7	1650.1	930.6	2580.6	3.7461	5.2455	160.
170.	352.4	1.7702	0.008364	1660.2	2405.0	1690.3	856.9	2547.2	3.8079	5.1777	170.
180.	357.1	1.8397	0.007489	1698.9	2374.3	1732.0	777.1	2509.1	3.8715	5.1044	180.
190.	361.5	1.9243	0.006657	1739.9	2338.1	1776.5	688.0	2464.5	3.9388	5.0228	190.
200.	365.8	2.036	0.005834	1785.6	2293.0	1826.3	583.4	2409.7	4.0139	4.9269	200.
220.9	374.1	3.155	0.003155	2029.6	2029.6	2099.3	0	2099.3	4.4298	4.4298	220.9

v_f = (table value)/1000

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

Mid Semester Examination — Winter Semester, A.Y. 2017-2018
Course Code: MCE 4717 — Time : 1.5 hours
Course Title: Engineering Economy — Full Marks : 50

There are **4 (four)** Questions. Answer any **3 (three)** of them.
Marks in the Margin indicate the full marks. The symbols have their usual meaning.

1. a) Derive the following equation where the symbols have their usual meanings: 4

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

b) A local university has initiated a logo-licensing program with the clothier Holister, Inc. Estimated fees (revenues) are \$80,000 for the first year with uniform increases to a total of \$200,000 by the end of year 9. Determine the gradient and construct a cash flow diagram that identifies the base amount and the gradient series. 5⅔

c) A design-build-operate engineering company in Texas that owns a sizable amount of land plans to lease the drilling rights (oil and gas only) to a mining and exploration company. The contract calls for the mining company to pay \$20,000 per year for 20 years beginning 3 years from now (i.e., beginning at the end of year 3 and continuing through year 22) plus \$10,000 six years from now and \$15,000 sixteen years from now. Utilize engineering economy relations to determine the total present worth in year 0 and annual series over the first 10 years at 15% per year. 7

2. a) For the cash flows shown, determine the present worth in year 0, if the interest rate is 12% per year. 7⅔

Year	1	2	3	4	5	6	7	8	9	10
Cash Flows, \$	13	13	13	13	16	19	22	25	28	31

b) Chemical engineers at a Coleman Industries plant in the Midwest have determined that a small amount of a newly available chemical additive will increase the water repellency of Coleman's tent fabric by 20%. The plant superintendent has arranged to purchase the additive through a 5-year contract at \$7000 per year, starting 1 year from now. He expects the annual price to increase by 12% per year thereafter for the next 8 years. Additionally, an initial investment of \$35,000 was made now to prepare a site suitable for the contractor to deliver the additive. Use i = 15% per year to determine the equivalent total present worth for all these cash flows. 9

3. a) Accurate air flow measurement requires straight unobstructed pipe for a minimum of 10 diameters upstream and 5 diameters downstream of the measuring device. In a field application, physical constraints compromise the pipe layout, so the engineer is considering installing the air flow probes in an elbow, knowing that flow measurement will be less accurate but good enough for process control. This is plan 1, which will be in place for only 3 years, after which a more accurate flow measurement system with the same costs as plan 1 will be available. This plan will have a first cost of \$26,000 with an annual maintenance cost estimated at \$5000. 7⅔

Plan 2 involves installation of a recently designed submersible airflow probe. The stainless steel probe can be installed in a drop pipe with the transmitter located in a

waterproof enclosure on the handrail. The first cost of this system is $83,000, but because it is accurate and more durable, it will not have to be replaced for at least 6 years. Its maintenance cost is estimated to be $1400 per year plus $2500 in year 3 for replacement of signal processing software. Neither system will have a salvage value. At an interest rate of 12% per year, which one should be selected on the basis of a present worth comparison?

b) An electric switch manufacturing company has to choose one of three different assembly methods. Method A will have a first cost of $40,000, an annual operating cost of $9000, and a service life of 2 years. Method B will cost $80,000 to buy and will have an annual operating cost of $6000 overits 4-year service life. Method C will cost $130,000 initially with an annual operating cost of $4000 over its 8-year life. Methods A and B will have no salvage value, but method C will have some equipment worth an estimated $12,000. Which method should be selected? Use present worth analysis at an interest rate of 12% per year. 9

4. a) National Home builders, Inc., plans to purchase new cut-and-finish equipment. Two manufacturers offered the estimates below. Determine which vendor should be selected on the basis of a present worth comparison, if the MARR is 15% per year. 7⅔

	Vendor A	Vendor B
First cost, $	–15,000	–18,000
Annual M&O cost, $ per year	–3,500	–3,100
Salvage value, $	1,000	2,000
Life, years	6	9

b) Two manufacturers supply MRI systems for medical imaging. St. Jude's Hospital wishes to replace its current MRI equipment that was purchased 8 years ago with the newer technology and clarity of a state-of-the-art system. System K will have a first cost of $1,600,000, an operating cost of $70,000 per year, and a salvage value of $400,000 after its 4-year life. System L will have a first cost of $2,100,000, an operating cost of $50,000 the first year with an expected increase of $3000 per year thereafter, and no salvage value after its 8-year life. Which system should be selected on the basis of a future worth analysis at an interest rate of 12% per year? 9

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$$(P_g/A_1, g, i, n) = \frac{1 - \left(\frac{1+g}{1+i}\right)^n}{i - g} \quad when\ g \neq i$$

$$(P_g/A_1, g, i, n) = \frac{n}{1+i} \quad when\ g = i$$

15% Compound Interest Factors 15%

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

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. 7th Semester (MCE)/BSc TE 1st (1-yr) & 3rd Sem(TVE) 19 March 2018(Afternoon)

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

Mid Semester Examination — Winter Semester, A.Y. 2017-18
Course Code: MCE 4725 — Time : 1½ hours
Course Title: Machine Maintenance Engineering — 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) Describe different types of maintenance with their merits and demerits. 12

b) The records of computer breakdown for Company PCK for the past 20 months are shown in the table. Each time computer breakdown estimated loss is $300. Contract preventive maintenance by company DK costs $220 per month. It is found that with preventive maintenance expected breakdown comes up as 1(one) breakdown per month. What will be the decision of PCK? 13

No of breakdown	No of months breakdown occurs
0	4
1	8
2	6
3	2

2 a) Describe the failure rate at different stages of the life cycle of a product using bath-tub curve. 7

b) Define reliability. A machine has failure pattern under Weibull distribution with a shape parameter of 1/3 and scale parameter of 16,000 hours . 12
i) Find its Reliability function, MTTF, median and mode.
ii) What would be its design life if 90 percent reliability is desired?
iii) If the machine runs for 10,000 hours, what would be the reliability?

c) Two pumps each having Weibull failure distribution with shape parameter of ½ and characteristic life of 1,000 hours are configured to provide a redundant system. Find the system reliability for a 150 hours mission and the system MTTF. 6

3 a) Write down the functions of work orders with a diagram showing different elements of a work order 9

b) What do you understand by series network for reliability analysis? A jet engine consists of five modules each of which was found to have a series Weibull failure distribution with a shape parameter of 1.5. Their scale parameters in operating cycles are as follows: 3,600, 7,100, 5,950, 4,680, and 9,260 hours. Find MTTF and median time to failure of the engine. 8

c) Describe 5S method with features. 8

4 a) Describe the procedure to judge Weibull distribution using plotting paper through ranking and state the relevant steps to find out the shape parameter and characteristics life. 10

b) Describe different steps of a systematic maintenance strategy with an example. 15

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Formulas MCE 4725

$R(t) = e^{-(\frac{t}{\theta})^{\beta}}$

$MTTF = \theta\Gamma\left(1+\frac{1}{\beta}\right)$

$\sigma^2 = \theta^2\left\{\Gamma\left(1+\frac{2}{\beta}\right) - \left[\Gamma\left(1+\frac{1}{\beta}\right)\right]^2\right\}$

$t_R = \theta\,(-lnR)^{1/\beta}$

$t_{med} = \theta\,(-ln0.5)^{1/\beta}$

$t_{mode} = \theta\left(1-\frac{1}{\beta}\right)^{1/\beta}$ when $\beta > 1$

$= 0$ when $\beta <= 1$

$\Theta_s = \left[\sum_{i=1}^{n}\left(\frac{1}{\theta_i}\right)^{\beta}\right]^{-1/\beta}$

$R(t) = \exp\left[-n\left(\frac{t}{\theta}\right)^{\beta}\right]$

$R(t) = \exp\left[-n\left(\frac{t-t_0}{\theta}\right)^{\beta}\right]$ when $t >= t_0$

$\lambda(t) = \frac{\beta}{\theta}\left(\frac{t-t_0}{\theta}\right)^{\beta-1}$ when $t >= t_0$

$MTTF = t_0 + \theta\,\Gamma\left(1+\frac{1}{\beta}\right)$

$t_{med} = t_0 + \theta\,(0.69315)^{1/\beta}$

$t_d = t_0 + \theta\,(-lnR)^{1/\beta}$

$R_s(t) = 1 - \left[1 - e^{-(\frac{t}{\theta})^{\beta}}\right]^2$

$MTTF = \theta\,\Gamma\left(1+\frac{1}{\beta}\right)(2 - 2^{-\frac{1}{\beta}})$

$\mu = \lambda + 1/ts$

$H(t) = 1 - e^{-t/MTTR}$

$Cost = C_a + (t_d / MTBF)\,(C_f + C_v\,MTTR)$

$$P(A|B) = \frac{P(B|A)\cdot P(A)}{\sum_i P(B|A_i)\cdot P(A_i)}$$

B.Sc.Engg. (M)7th Sem./B.Sc. TE(1 Yr. Prog.),1st Sem./ 48
B.Sc. TE (2 Yr. Prog), 3rd Sem. 13 March, 2018 (Aft.)

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

Semester Mid-term Examination
Course No. MCE 4739/MCE 4797
Course Title: Machine Design - II

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

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

1. a) What is fundamental law of gearing? Describe the profiles satisfying law of gearing. Write down the advantages of involute gears. 12
   b) With the help of diagram describe the meshing of two pairs of gear teeth along with explanation of the various terminologies used in involute gearing. 13

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 340Bhn and runs at 1720 rpm. The driven gear is of hardness 280Bhn 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 385MPa 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 1. Place the answers in the tabular form as Table 1. 25

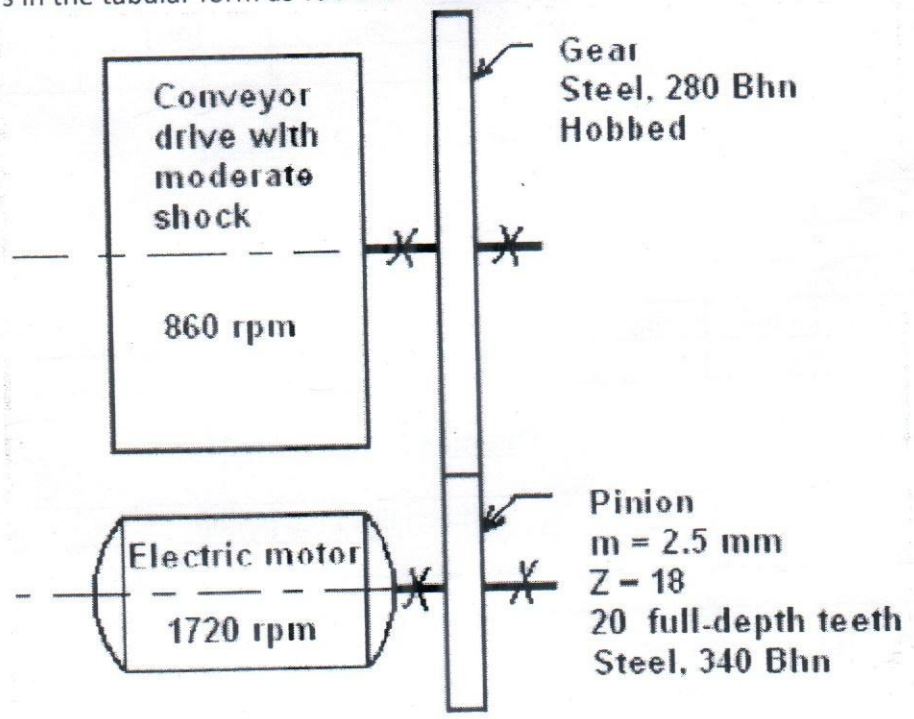

Fig. 1

3. A helical gear drive shown in Fig.2 transmits 20 kW power at 1440 rpm to a machine input shaft running at 360rpm. The motor shaft pinion has 18 teeth, 20 ° normal pressure angle and a normal module of 4mm and 30 ° right hand helix. Determine all 25

dimensions of the gear and the pinion.Pinion tooth length b=1.2 x p_a. Comment the chosen gears Place the answers in the tabular form as Table 2.

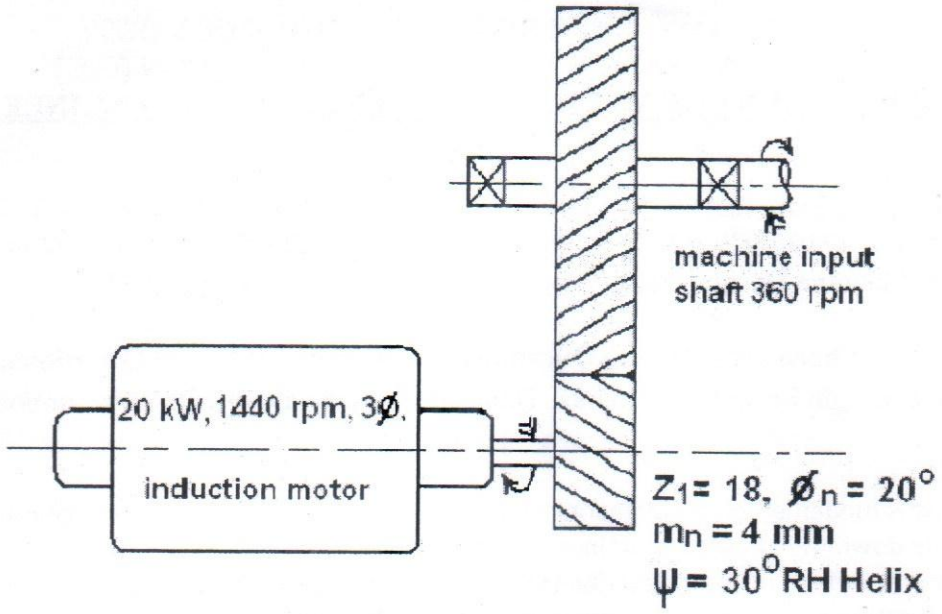

Fig.2

4. A bevel gear pair has to be designed to transmit 6 kW power at 750 rpm. The shaft angle is 90°. Speed ratio desired is about 2.5. The prime mover is induction motor and the driven side is connected to a belt conveyor. Place the answers in the tabular form as Table 3. 25

Question No. 2 (Table 1)

σ_{b1}	σ_{b2}	σ_{H1}	σ_{H2}	$[\sigma_{b1}]$	$[\sigma_{b2}]$	F_{tmax}

Question No. 3 (Table 2)

φ	m	d_1	d_2	p	p_a	b	v	F_t	F_r	F_a	F_n

σ_{b1}	σ_{b2}	σ_{H1}	σ_{H2}	$[\sigma_{b1}]$	$[\sigma_{b2}]$	$[\sigma_{H1}]$	$[\sigma_{H1}]$	S_{b1}	S_{b2}	S_{H1}	S_{H2}

Question No. 4 (Table 3)

m	b	Materials of the pinion		Materials of the gear	
		σ_{ut}	BHn	σ_{ut}	BHn

B.Sc. Engg. (M)/7th Sem

March 19, 2018 (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. 2017-2018
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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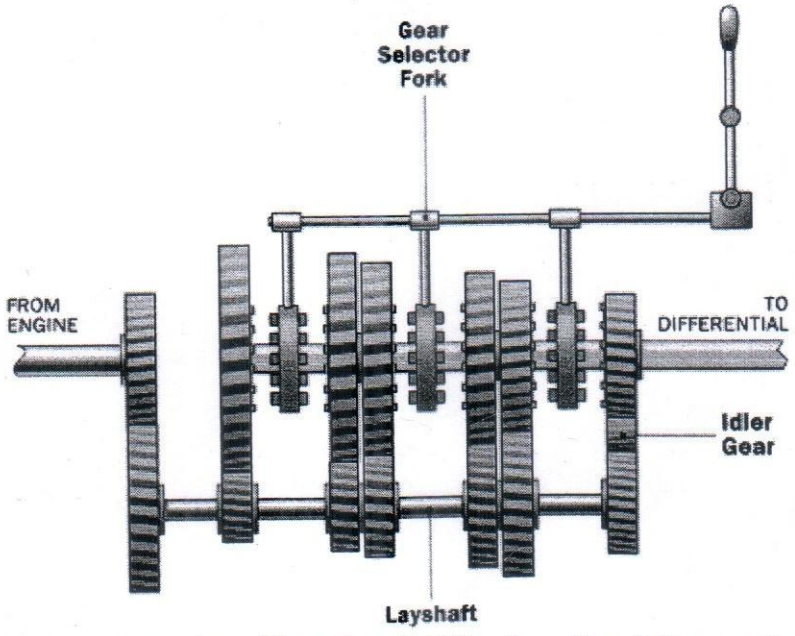
1. a) What is an Automobile? Discuss the general layout of a rear wheel drive automobile. 15
   b) Classify engine depending on its number of strokes and cylinder arrangements. 10

2. a) Briefly describe the working principle of sequential gas injection system (SGIS). 15
   b) Explain the operational principle of fuel pump that is used for EFI system. 10

3. a) What do you mean by air-conditioning of passenger cars and buses? Explain with a diagram of the automobile air-conditioning system used on a passenger car. How does this system differ from domestic air-conditioning system? 15
   b) Draw the valve timing diagram for SI and CI engine. 10

4. a) A manual transmission gearbox is shown in figure 1. Explain the necessary connecting arrangement for achieving the followings: 15
   i) Maximum speed *ii)* Minimum speed *iii)* Reverse speed



   b) Describe constant mesh gear box. How does it differ from the sliding mesh gear box? 10

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BSc.Eng. (EEE)/7th Semester 16 March 2018 (Afternoon)

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

Mid Semester Examination — Winter Semester, A.Y. 2017-2018
Course Code: MCE 4791 — Time : 1½ hours
Course Title: Engineering Economics — Full Marks : 50

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

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

1. a) Derive the following equation where symbols have their usual meanings 4

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

b) Describe MARR and rule of 72 with numeric examples $5^2/_3$

c) Write down four main differences between Conventional and Islamic Banking, and describe Shirkatul Melk Hire purchase mode of Islamic finance with a numerical example. 7

2. a) A company that manufactures compressors is trying to decide between the machines shown below. Compare them on the basis of their Present Worth(PW) values, using an interest rate of 12% per year. 13

	Machine A	Machine B
First cost, $	270,000	320,000
Annual Operating Cost,$/year	200,000	300,000
Onetime overhauling cost in year 3, $	Not Applicable	26,000
Onetime overhauling cost in year 2, $	140,000	Not Applicable
Servicing cost, $	$ 500 at year 2 and then increases by $50 every year	$ 300 at year 3 and then increases by 2% every year
Salvage value	19,000	30,000
Life, years	6	9

b) Write down four main differences between Corporations/Limited Companies and Cooperatives. $3^2/_3$

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

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

b) Describe Peer to Peer(P2P) financing with an example. $6^2/_3$

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

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

b) How much must you deposit in your retirement account now if you want to be able to withdraw $80,000 per year forever beginning 30 years from now? Assume the account earns interest at 12% per year. $4^2/_3$

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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

M.Sc.Engg. (M) 19 March 2018 (Afternoon)

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

MID SEMESTER EXAMINATION
MCE 6109 Mechanical Vibrations

WINTER SEMESTER: 2017-2018
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) Determine the equivalent mass of the system shown in Fig.1, where the rigid link 1 is attached to the pulley and rotates with it. (13)

   b) Derive the equation of motion of the system shown in Fig.2. Then, determine the stability conditions for this system. (12)

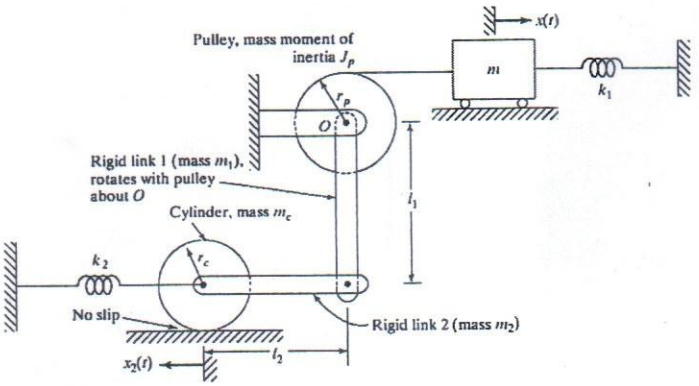


Fig.1

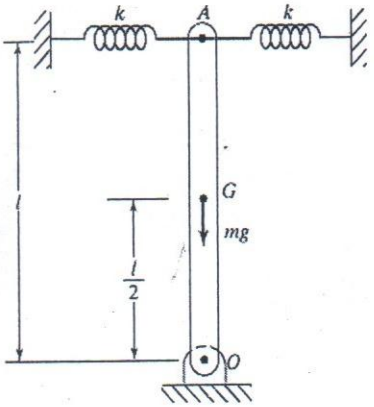


Fig.2

2. An automobile moving over a rough road shown in Fig.3 can be modelled considering a) weight of the car body, passengers, seats, front wheels and rear wheels; b) elasticity of the tires (suspension), main springs, and seats; c) damping of the seats, shock absorber, and tires. Develop three physical and mathematical models of the system using a gradual refinement in the modelling process. (25)

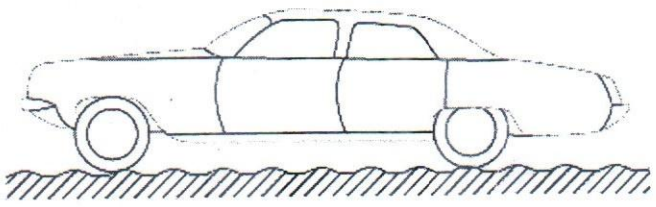


Fig.3

3. a) The column of the water tank shown in Fig.4 is 400 ft. high and is made of reinforced concrete with a tabular cross section of inner diameter 9 ft. and 11 ft. The tank weighs 7×10^5lb with water. By neglecting the mass of the column and assuming the Young's modulus of reinforced concrete as 5×10^6 psi, determine the following: (13)

   i) The natural frequency and the natural time period of transverse vibration

   ii) The vibration response of the water tank due to an initial transverse displacement of 10 in.

   iii) The maximum values of the velocity and acceleration experienced by the water tank.

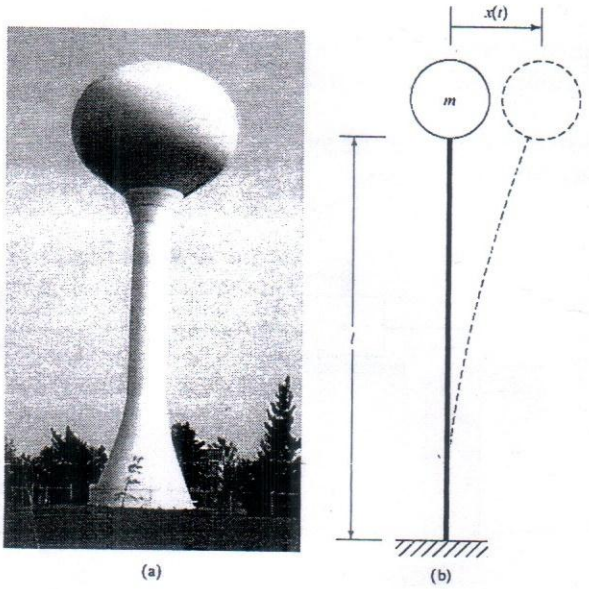


Fig.4

b) A mass-spring-damper system can be defined as a mathematical model for free vibration as $m\ddot{x} + c\dot{x} + kx = 0$. Derive the complementary solution in terms of damping ratio and natural frequency. Determine also the conditions for underdamping, critical damping and over damping. (12)

4. A mass-spring-damper system can be defined as a mathematical model for forced vibration as $m\ddot{x} + c\dot{x} + kx = F_0 \cos\omega t$. Derive the expression of the amplitude ratio (X/δ_{st}) and phase angle in terms of damping ratio and frequency ratio. Draw the response and phase angle curves vs. frequency ratio from the derivation and discuss the characteristics depicted in the curves. (25)

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

Mid Semester Examination — Winter Semester, A.Y. 2017-2018
Course Code: MCE 6121 — Time : 1½ hours
Course Title: Advanced Topics in Manufacturing — Full Marks : 75

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

Marks in the Margin indicate the full marks.

1 a) Explain in details the different types of Engineering Materials used in Manufacturing industries. 10

b) Explain with necessary diagram the models of production systems and hence find out the relationship others support systems used in Industries. 10

c) Classify with examples the different categories of manufacturing industries. 5

2 a) Explain with neat sketches the Laser beam machining (LBM) and Plasma Arc Machining (PAM) processes. 14

b) Explain the mechanism of using Electro-Chemical Machining and write down the advantages and disadvantages of Electro-Chemical Machining. 11

3 a) Four machines used to produce a family of parts are to be arranged into a GT cell. The from-to data for the parts processed by the machines are shown in the table below. (i) Determine the most logical sequence of machines for this data using Hollier's method (ii) Construct the flow diagram for the data, showing where and how many parts enter and exit the system. (iii) Compute the percentage of in-sequence moves and the percentage of back-tracking moves in the solution. (iv) Develop a feasible layout plan for the cell. 14

	To:			
From:	1	2	3	4
1	0	10	0	40
2	0	0	0	0
3	50	0	0	20
4	0	50	0	0

b) Explain briefly the different steps of Production Flow Analysis (PFA) method for identifying the part families and associated machine grouping. 11

4 a) How the different storage system performance is measured and explains briefly the storage location strategies used in storage system. 11

b) An AS/RS with four aisles is 80 m long and 18 m high. The S/R machine has a maximum speed of 1.6 m/s in the horizontal direction. It accelerates from zero to 1.6 m/s in a distance of 2.0 m. On approaching its target position (where the S/R machine will transfer a load onto or off of its platform), it decelerates from 1.6 m/s to a full stop in 2.0 m. The maximum vertical speed is 0.5 m/s, and the acceleration and deceleration distances are each 0.3 m. Rates of acceleration and deceleration are constant in both directions. Pick and deposit time = 12 s. Utilization of the AS/RS is assumed to be 90%, and the number of dual command cycles = the number of single command cycles. (i) Calculate the single command and dual command cycle times, including considerations for acceleration and deceleration. (ii) Determine the throughput rate for the system. 14

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

Mid SemesterExamination — Winter Semester, A.Y. 2017-2018
Course Code:MCE 6193 — Time : 1.5 hours
Course Title: Intermediate Fluid Mechanics — Full Marks : 75

There are **4 (four)** Questions. Answer any **3 (three)** of them.
Marks in the Margin indicate the full marks. The symbols have their usual meaning.

1. a) Write short notes on the following: 4×3
   i) Compressible flow and incompressible flow
   ii) Laminar flow and turbulent flow
   iii) Steady flow and unsteady flow

   b) Determine the density, specific gravity, and mass of the air in a room whose dimensions are 4 m × 5 m × 6 m at 100 kPa and 25°C 13

2. a) Derive Newton's law of viscosity with the appropriate diagram and usual notations. 12

   b) The viscosity of a fluid is to be measured by a viscometer constructed of two 40 cmlong concentric cylinders. The outer diameter of the inner cylinder is 12 cm, and the gap between the two cylinders is 0.15 cm. The inner cylinder is rotated at 300 rpm, and the torque is measured to be 1.8 N/m. Determine the viscosity of the fluid. 13

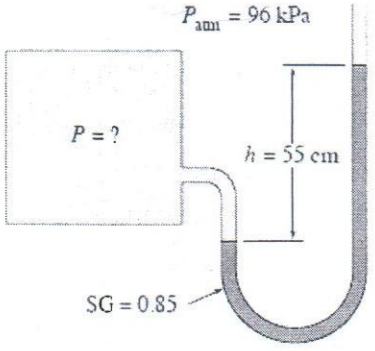
3. a) Briefly explain no slip condition and boundary layer with neat sketches. 5×2

   b) Write short note on ideal gas equation of state. 4

   c) Determine the atmospheric pressure at a location where the barometric reading is 740 mm Hg and the gravitational acceleration is g=9.805 m/s^2. Assume the temperature of mercury to be 10°C, at which its density is 13,570 kg/m^3. 11

4. a) Briefly explain the following (use equations and neat sketches where required): 5×3
   i) Surface tension and capillary effect
   ii) Bulk modulus of elasticity
   iii) Coefficient of volume expansion

   b) A manometer is used to measure the pressure of a gas in a tank. The fluid used has a specific gravity of 0.85, and the manometer column height is 55 cm, as shown in Fig. If the local atmospheric pressure is 96 kPa, determine the absolute pressure within the tank. 10



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MSc TE/ 3rd Sem 13 March 2018 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

MID SEMESTER EXAMINATION — WINTER SEMESTER: 2017-2018

Course No: MCE 6393 — TIME : 1HR 30 MIN

Course Name: Advanced Heat Transfer — FULL MARKS: 75

There are **Four** Questions. Answer any **Three** Questions.
Assume reasonable value for missing data.

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1. a) How thermodynamic laws can be applied to heat transfer in a system. Explain how the heat is conducted in solids. (10)

   b) A plane wall is **100 mm** thick and its wall area is **6 m^2**. If its conductivity is **8.5 W/m^oC** and surface temperatures are steady at **200^oC** and **30^oC** , determine: (15)

   (i) Heat flow across the plane wall.
   (ii) Temperature gradient in the flow direction.

2. a) Write assumptions on which Fourier's law of Heat Conduction is based. State some essential features of the Fourier's law. (10)

   b) The following data are related to a an oven: (15)

   Thickness of side wall of the oven = **82.5 mm**

   Thermal conductivity of wall insulation = **0.044 W/m^oC**

   Temperature on inside of the wall = **175 ^oC**

   Energy dissipated by the electrical coil within the oven = **40.5 W**

   Determine the area of wall surface, perpendicular to heat flow, so that temperature on the other side of the wall does not exceed **75^oC**.

3. a) Make analogy between heat conduction equation and electric-circuit theory. Define convective heat transfer co-efficient (h). Write different factors on which the value of h depends. Explain heat transfer phenomena for flow over a heated flat plate. (10)

   b) A carbon steel plate (thermal conductivity = **45 W/m^oC**) with a dimension of **600mm × 900mm × 25mm** is maintained at **310^oC**. Air at **15^oC** blows over the hot plate. If convective heat transfer co-efficient is **22 W/ $m^{2o}C$** and **250 W** is lost from the plate surface by radiation, calculate the inside plate temperature. (15)

4. a) Write the following equation for three dimensional heat conduction in elaborative manner (10)

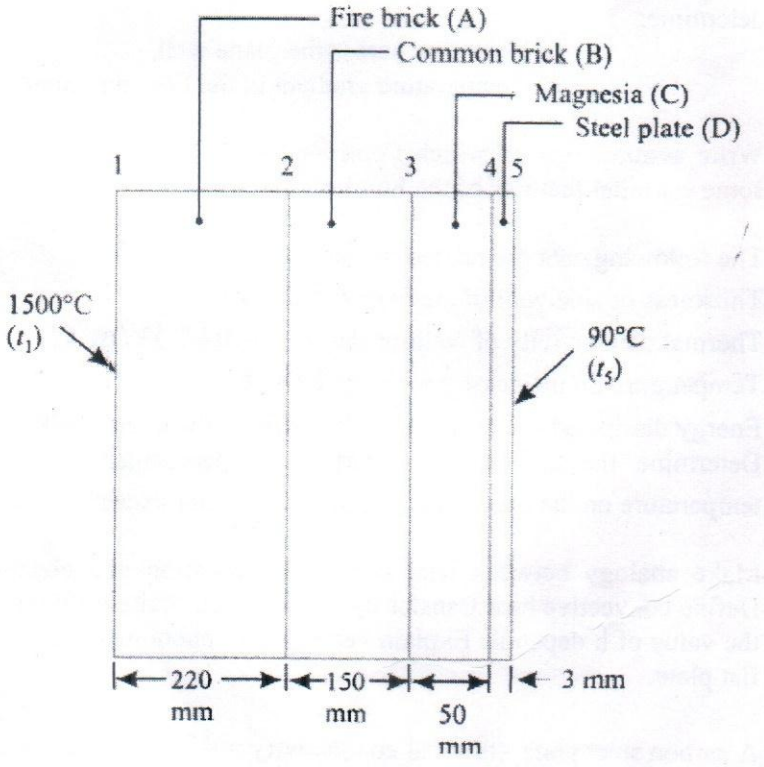
$$\nabla .(k\nabla t) + q_g = \rho.c.\frac{\partial t}{\partial \tau}$$

Simplify the equation for the following cases:

(i) Constant thermal conductivity.

(ii) Steady three dimensional.

b) A furnace wall as shown in the following figure is composed of **220 mm** of fire brick, **150 mm** of common brick, **50 mm** of **85%** magnesia and **3 mm** of steel plate on outside. If the inside surface temperature is **1500°C** outside surface temperature is **90°C**, estimate the temperatures between the layers and calculate the heat loss in kJ/h-m^2. Assume k for fire brick = **4 kJ/mh °C**, k for common brick=**2.8 kJ/mh °C**, k for 85% magnesia = **0.24 kJ/mh °C** and k for steel = **240 kJ/mh °C.** (15)



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B.Sc. Engg.(EE), 1st Sem. Date: March 19, 2018 (Morning)

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 4101
Course Title: Electrical Circuit -I

Winter Semester, A. Y. 2017-2018
Time: 90 Minutes
Full Marks: 75

There are **4 (four)** questions. Answer **any 3 (three)** questions. All questions carry equal marks. Figures in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper.

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1. a) Why are the relationship among charge(Q) and current(I), power(P) and energy(W) for DC are not adequate for time varying electricity? Derive their relationship for the later case. What is the difference between the independent and dependent electrical sources? Name the dependent electrical sources with their control variable. 5

b) The current flowing through an electrical element is depicted in Fig. 1(b) below. Sketch the corresponding charge and verify. 10

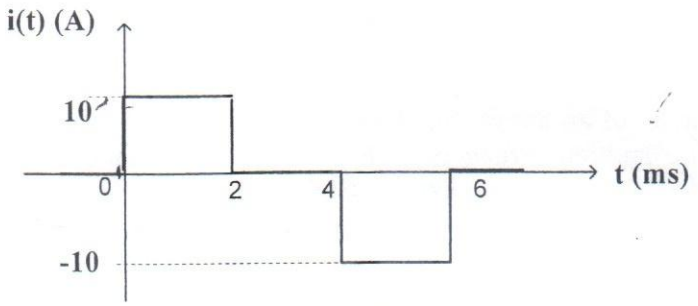

Fig. 1(b).

c) Find the power associated with each element in Fig. 1(c) and verify Tellegen's theorem. 10

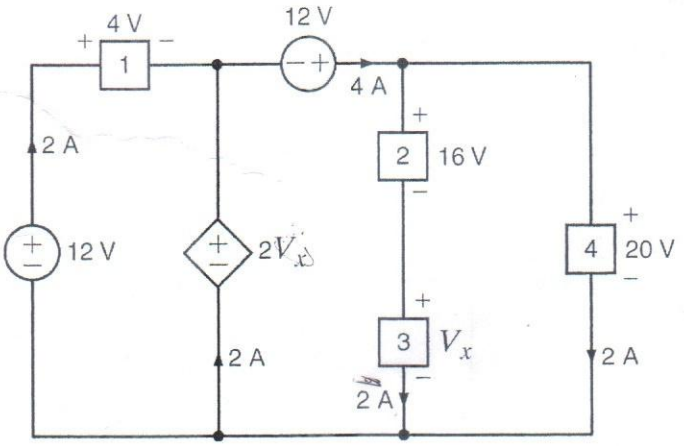

Fig. 1(c).

2. a) Name some practical applications of current divide rule and potential divide rule? Apply the rules in the electrical circuit shown in Fig. 2(a) to find V_x and I_x. 10

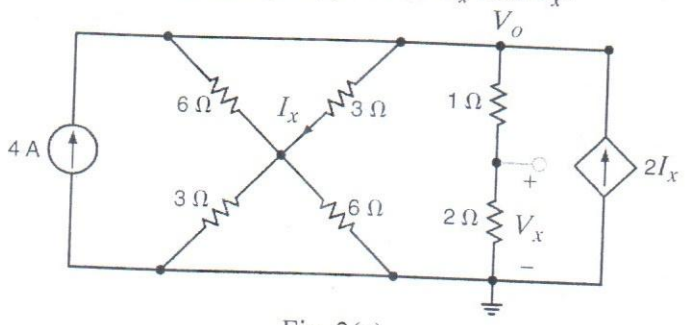

Fig. 2(a).

b) A simplified equivalent circuit of a typical transistor amplifier can be drawn as shown in Fig. 2(b). Find the current, voltage and power associated with 20 kΩ resistor. 10

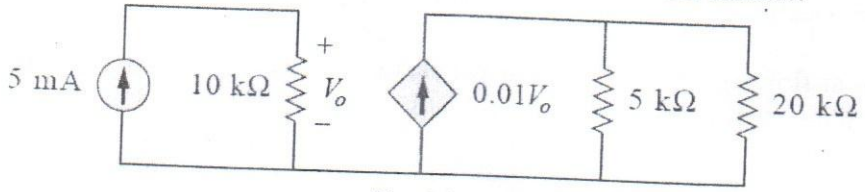

Fig. 2(b).

c) A conceptual model of an automobile head light and ignition system is shown in Fig. 2(c) below. When the ignition switch is OFF the head lights take about 2.0 A to give full illumination. What happens when both headlight and ignition switches are ON. The ignition system typically draws around 100 A. The typical value of battery resistant is $R_{batt} = 25\,\text{m}\Omega$. 5

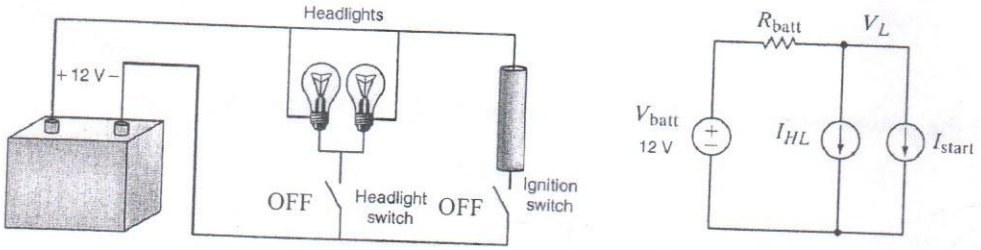

Fig. 2(c).

3. a) Using Δ-Y transformation technique, find the voltage V_o, I and power supplied by the source. 10

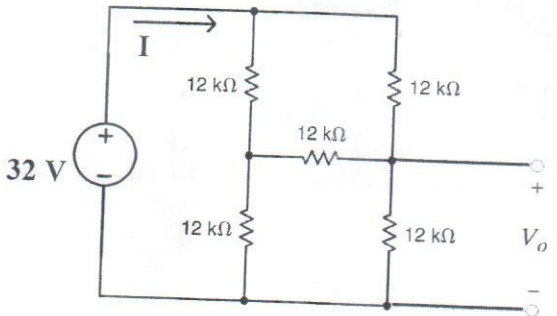

Fig. 3(a)

b) Show by a simple example that if an electrical circuit has N numbers of essential nodes then N-1 lineraly independent nodal equations can be derived using Kirchoff's Current Law(KCL). 5

c) Find V_o and I_A in Fig. 3(c) using nodal analysis. 10

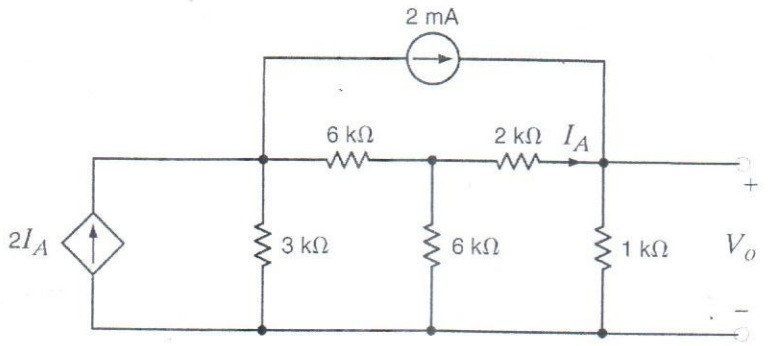

Fig. 3(c)

4. a) Describe the technique of (i) finding node voltages of an electrical network that contains a voltage source between two non-reference nodes; and(ii) finding loop currents when a current source is shared by two adjacent loops. 5

b) Using the concept of supernode find V_x and V_o in the circuit in Fig. 4(b). All resistances are of equal value 1.0 kΩ. 10

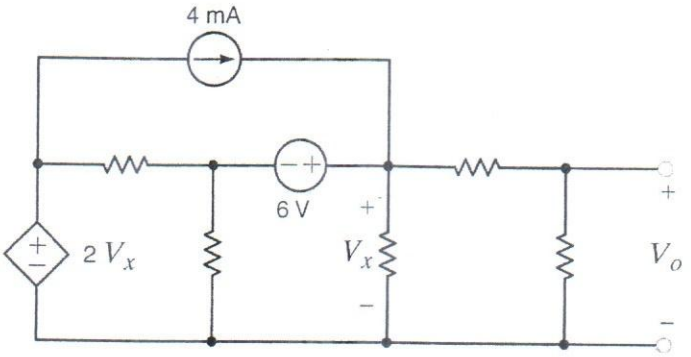

Fig. 4(b).

c) Find V_o in the circuit shown in Fig. 4(c) using loop analysis. 10

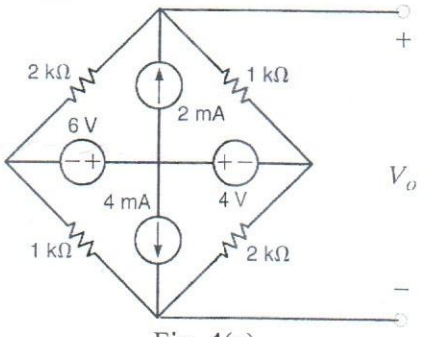

Fig. 4(c).