BSc. Engg. IPE (1st Sem) 25 February,2020(Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING (MPE)

Mid Semester Examination | Summer Semester :A.Y. 2019-2020
Course Code:**IPE-4101** | Time : **1.5Hours**
Course Title: **Introduction to IPE** | Full Marks : **75**

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

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1 a) What are the characteristics of a company? Briefly explain. 7

b) According to the three-sector theory, all economic activities can be classified into any one of the three main sectors: primary, secondary and tertiary. Discuss these three main sectors with examples. 6

c) Describe the history of the evolution of manufacturing and industrial sectors. 12

2 a) Define the term management. Explain why efficiency and effectiveness are important to management. 5

b) Explain briefly the Taylor's five principles of management? Discuss in short. 8

c) How does motivation of employees works for an organization? Both managerial and leadership skill are important for managers to be successful. Explain with the help of managers' functions and traits of the successful leaders. 12

3 a) All organizations producing goods and services have three essential functions. Explain each of them. Provide one manufacturing industry as an example. 6

b) How do you differentiate between production and productivity. 6

c) Compute the multifactor productivity measure for each of the weeks shown for production of chocolate bars. Assume 40-hour weeks and an hourly wage of $10. Overhead is 1.5 times weekly labour cost. Material cost is $8 per pound. (Round your answers to 2 decimal places.) 13

Week	Output (units)	Workers	Material (lbs)
1	30,000	54	30
2	33,000	84	7

4 a) What do you understand by Product Life Cycle ? Explain with necessary sketches. 06

b) The number of pizzas ordered on Friday evenings between 5:30 and 6:30 at a pizza delivery location for the last 10 weeks is given as follows: 58, 46, 55, 39, 42, 63, 54, 55, 61, 52. Forecast the pizza demand for 5^{th} to 10^{th} week using 4 week moving average. 07

c) Define the term quality. Briefly explain six sigma tool used for process improvement. 12

B Sc. Eng.(ME/IPE)(1st Semester) 27 February, 2020(Afternoon)

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

Mid Semester Examination
Course Code: Math 4111
Course Title: Modelling with calculus and ODE

Winter Semester, A.Y. 2019-2020
Time : 1½ hours
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) A function $f(x)$ is defined: **12.5**

$$f(x)=\begin{cases}4, & x\le 0\\ 3-x^2, & 0<x\le 2\\ 2x-6, & x>2\end{cases}$$

Graph the function and answer the following questions.

i) What are the domain and range of f?

ii) At what points c, if any, does $\lim_{x\to c} f(x)$ exist?

iii) At what points does only the left-hand limit exist?

iv) At what points does only the right-hand limit exist?

b) In a study, data were gathered that showed the relationship between the death rate of men and the average number of hours per day that the men slept. These data are listed in the following table. **12.5**

Average Number of Hours of Sleep, x	Death Rate per 100,000 Males, y
5	1121
6	805
7	626
8	813
9	967

i) Make a scatterplot of the data, and determine whether the data seem to fit a quadratic function.

ii) Find a quadratic function that fits the data.

iii) Use the model to find the death rate for males who sleep 2 hr, 8 hr, and 10 hr.

2. a) Suppose the population of Gazipur city grows from an initial size of 100,000 to a size P given by **12.5**

$$P(t)=100,000+2000t^2$$

where t is in years.

i) Find the growth rate of P

ii) Find the population after 10 yr.

iii) Find the growth rate at $t = 10$

iv) Explain the meaning of your answer to part 2a(iii).

b) The temperature T of a admitted student at IUT medical Centre is modeled by the following equation: **12.5**

$$T(t)=\frac{4t}{t^2+1}+98.6$$

where T is the temperature, in degrees Fahrenheit, at time t, in hours.
i) Find the rate of change of the temperature with respect to time.
ii) Find the temperature at $t = 2$ hr.
iii) Find the rate of change of the temperature at $t = 2$ hr

3. **a)** According to the Bangladesh Bureau of Statistics (BBS), the number of professional services employees fluctuated during the period 2000–2010, as modeled by **12.5**

$$E(t) = -28.31t^3 + 381.86t^2 - 1162.07t + 16,905.87$$

where t is the number of years since 2000 and E is thousands of employees.
i) Find the relative extrema of the above modeled function using first derivative test.
ii) sketch the graph of given function.
iii) Interpret the meaning of the relative extrema.

b) For a dosage of x cubic centimeters (cc) of a certain drug, the resulting blood pressure B is approximated by **12.5**

$$B(x) = 305x^2 - 1830x^3, 0 \le x \le 0.16$$

Find the maximum blood pressure and the dosage at which it occurs.

4. **a)** Sketch the graph of the following function using the tools of calculus: **13**

$$f(x) = \frac{x^2 + 4}{x}$$

b) A few months ago, a night guard of AB bank ATM booth of Board bazar was murdered. At 6:30AM a coroner arrived in that murdered place for investigation. After that he took the temperature of the dead body and found it to be 94.6^0F. He then waited 1 hr, took the temperature again, and found it to be 93.4^0F. He also noted that the surrounding temperature at that time it was 70^0F. When was the murder committed? **12**

B.Sc. Eng. (EEE) 1st Semester 3 March 2020 (Morning)

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

Mid Semester Examination — Winter Semester, A.Y. 2019-2020
Course Code: Chem 4121 — Time : $1\frac{1}{2}$ 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) Derive integrated and differential form of Kirchhoff equation. 9

b) Classify element according based on their electron configurations. Find out the position of Ni in the periodic table. 10

c) The heat of combustion of ethyl alcohol is -330 kcal. The heat of formation of $CO_2(g)$ and $H_2O(l)$ are -94.03 kcal and 68.39 kcal, respectively. What is the heat of formation of ethyl alcohol? 6

2 a) Only draw the shape (and write the name) of the following molecules according to VSEPR model (i) $SiCl_4$, (ii) SF_6, (iii) XeF_2, and (iv) PF_5. 8

b) What is hydrogen bond? Classify hydrogen bond with examples. 5

c) Draw the molecular orbital diagram of CO molecule. State the bond order and magnetic properties. 7

d) What is octet rule? Write the limitation of octet rule. 5

3 a) State and explain Heisenberg's Uncertainty principle. Show the applicability of Uncertainty principle. 6

b) Derive an expression for the wavelength of electron which undergo a transition in a hydrogen atom. 12

c) Calculate the wavelength and energy of the emitted photon for the 4^{th} line of the Lyman series of the hydrogen atom emission spectra. 7

4 a) What is colligative property of a dilute solution? Show that lowering of vapour pressure is a colligative property. 7

b) Derive a relation between Depression of freezing point of a solution by the addition of nonvolatile solute and molar mass of the solute with the help of vapour pressure-temperature diagram. 12

c) The formula of an oligomer is $(C_6H_{10}O_5)n$, where n averages 200.00. When 0.798 g of compound is dissolved in 100.0 mL of water solution, what is the osmotic pressure at 25^0C? 6

B.Sc. Engg. (M) -1st Sem. 02 March 2020 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING (MPE)

MID SEMESTER EXAMINATION
Course No: ME-4151
Course Name: Engineering Mechanics

WINTER SEMESTER: 2019-2020
TIME : 1HR 30 MINS
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)** The spur gear shown in **Figure 1a** is subjected to the two forces caused by contact with other gears. Determine the resultant of the two forces and express the result as a Cartesian vector.

(b) The tractor has a weight of **363 Kg** with center of gravity at G shown in **Figure 1b**. Determine the greatest weight of the log that can be pushed up the incline. The coefficient of static friction between the log and the ground is $\mu_s = 0.5$, and between the rear wheels of the tractor and the ground $\mu_s' = 0.5$. The front wheels are free to roll. Assume the engine can develop enough torque to cause the rear wheels to slip.

2 **(a)** The ball D in **Figure 2a** has a mass of **20 kg**. If a force (F) of **100 N** is applied horizontally to the ring at A, determine the dimension d so that the force in cable AC is zero.

(b) In order to pull out the nail at B shown in **Figure 2b**, the force F exerted on the handle of the hammer must produce a clockwise moment of **56 Nm** about point A. Determine the required magnitude of force F.

3 **(a)** The uniform smooth rod shown in **Figure 3a** is subjected to a force and couple moment. If the rod is supported at A by a smooth wall and at B and C either at the top or bottom by rollers, determine the reactions at these supports. Neglect the weight of the rod.

(b) Determine the smallest lever force P needed to prevent the wheel from rotating if it is subjected to a torque of **M = 250 Nm.** The coefficient of static friction between the belt and the wheel is $\mu_s = 0.3$. The wheel is pin connected at its center B shown in **Figure 3b**.

4 **(a)** Determine the moment of inertia of the area about the y axis (**Figure 4a**).

(b) Determine the location $(\bar{x}, \bar{y})$ of the centroid of the wire shown in **Figure 4b**.

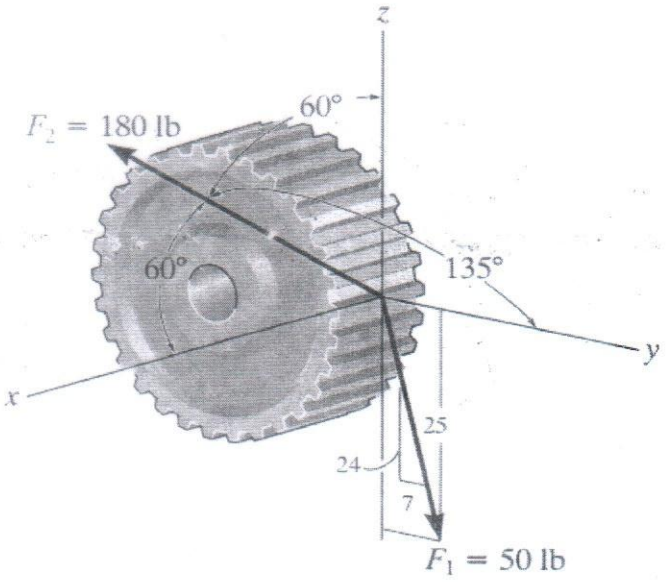

Figure-1a

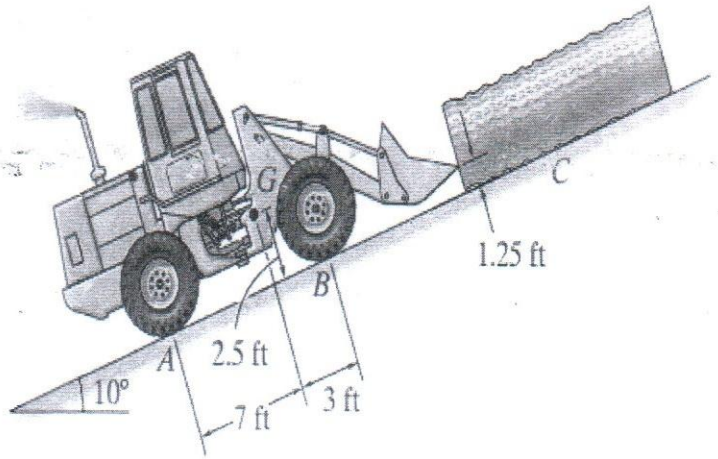

Figure-1b

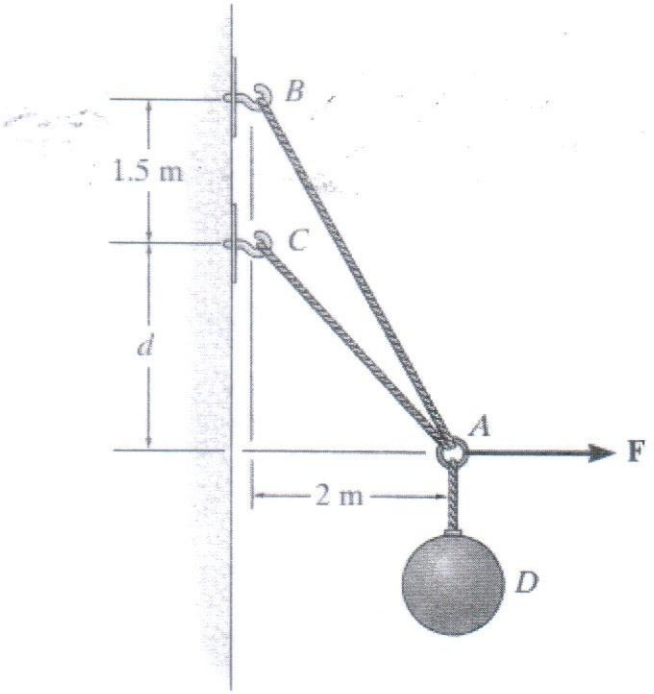

Figure-2a

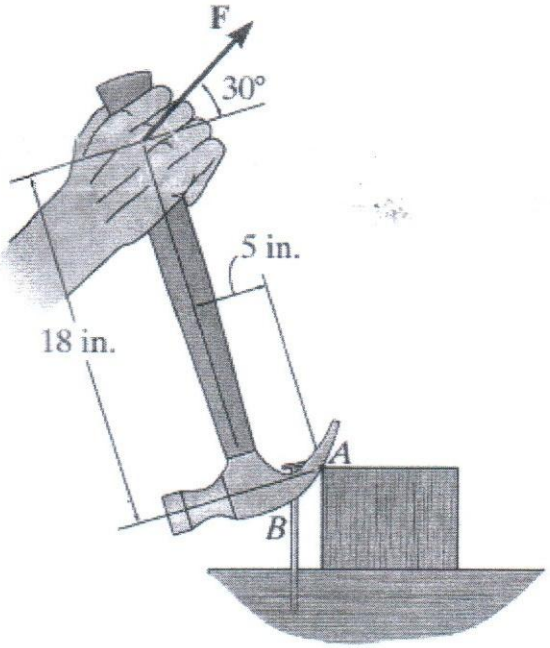

Figure-2b

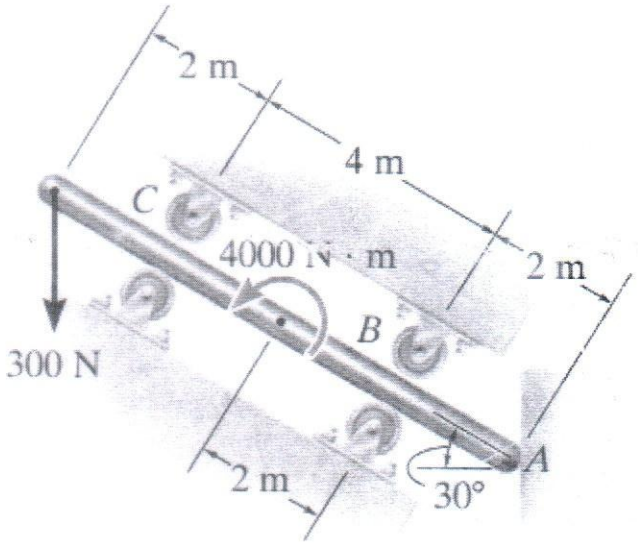

Figure-3a

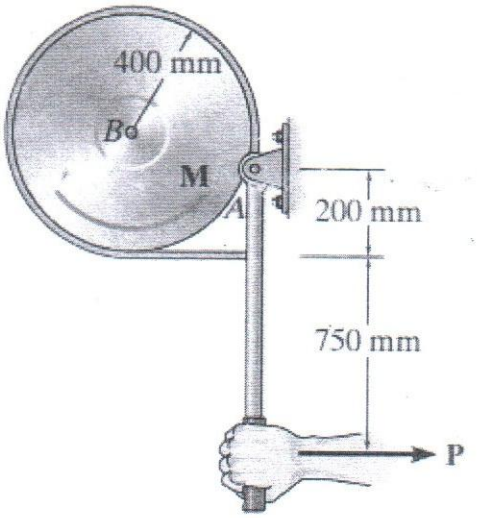

Figure-3b

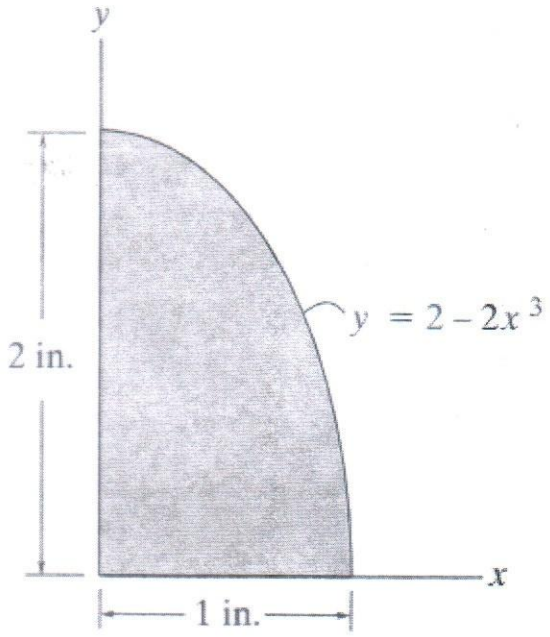

Figure-4a

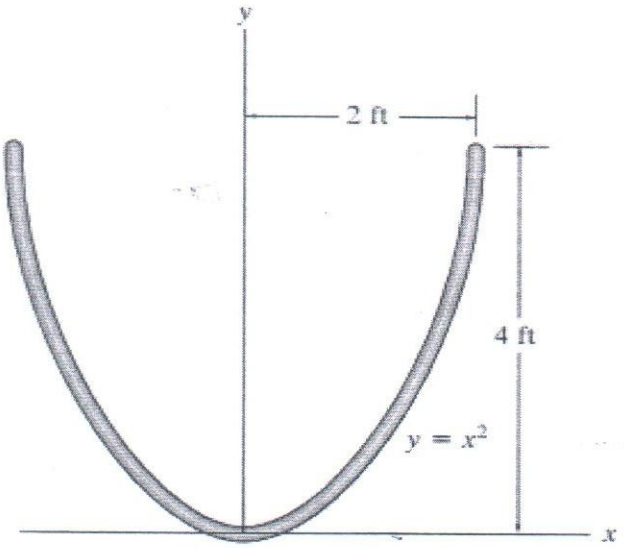

Figure-4b

B.Sc. Engg (M) 3rd sem — 28 February 2020 (Morning)

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

Mid Semester Examination — Winter Semester: A.Y. 2019-2020
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.
Figures in the right margin indicate full marks. Don't write on this question paper.
Assume any missing data

1. a) What is the State Postulate? From the energy equation applied to closed system for constant volume process and Joule's law, prove that change of internal energy is always given by $Q = m\,Cv\,(T_2-T_1)$. **(12)**

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

   b) What are the limitations of First Law of Thermodynamics? Show the equivalence of the two statements of the second Law of Thermodynamics. **(13)**

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

   b) In an air compressor, air flows steadily at the rate of 0.3 kg/s. The air enters the compressor at 5 m/s with a pressure of 1 bar and a specific volume of 0.5 m^3/kg. It leaves the compressor at 75 m/s with a pressure of 7 bar and a specific volume of 0.18 m^3/kg. The internal energy of the air leaving the compressor is 165 kJ/kg greater than that of the air entering. The compressor is insulated. Find the power required to drive the compressor. **(15)**

3. a) What are the Air Standard Assumptions of the Gas Power Cycles? **(5)**

   b) What will happen if petrol is used in diesel engine and vice versa? **(5)**

   c) Discuss the value of the Carnot Cycle in engineering. **(5)**

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

4. a) Show how efficiency of Otto cycle and Diesel Cycle vary with respect to compression ratio. For the same compression ratio, compare the efficiency of Otto cycle with Diesel Cycle. **(10)**

   b) An ideal Otto cycle has a compression ratio of 8. At the beginning of the compression process, air is at 100 kPa and 17 °C, and 800 kJ/kg of heat is transferred to air during the constant-volume heat-addition process. Determine (I) the maximum temperature and pressure that occur during the cycle, (II) the net work output, (III) the thermal efficiency, and (IV) the mean effective pressure for the cycle. Take for air, Cp= 1.005 kJ/kg K, Cp/Cv = 1.4 **(15)**

B. Sc. Engg. (M)/3rd Sem 24 February, 2020 (Morning)

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

Mid Semester Examination
Course Code: **MCE 4311**
Course Title: **Fluid Mechanics-I**

Winter Semester : **A.Y. 2019-2020**
Time : **1.5 Hours**
Full Marks : **100**

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

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1. (a) One of the common procedures in fitness programs is to determine the fat-to-muscle ratio of the body. This is based on the principle that the muscle tissue is denser than the fat tissue, and, thus, the higher the average density of the body, the higher is the fraction of muscle tissue. The average density of the body can be determined by weighing the person in air and also while submerged in water in a tank as shown in **Fig. 1**. Treating all tissues and bones (other than fat) as muscle with an equivalent density of ρ_{muscle}, obtain a relation for the volume fraction of body fat x_{fat}. **[06]**

(b) Obtain a relation for viscosity considering a fluid layer between two very large parallel plates immersed in a large body of a fluid. **[11]**

(c) A 50-cm X 30-cm X 20-cm block weighing 150 N is to be moved at a constant velocity of 0.8 m/s on an inclined surface with a friction coefficient of 0.27 as shown in **Fig. 2**. (*a*) Determine the force *F* that needs to be applied in the horizontal direction. (*b*) If a 0.4 mm-thick oil film with a dynamic viscosity of 0.012 Pa.s is applied between the block and inclined surface, determine the percent reduction in the required force. **[16.33]**

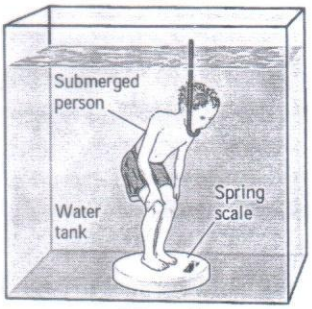

Fig. 1

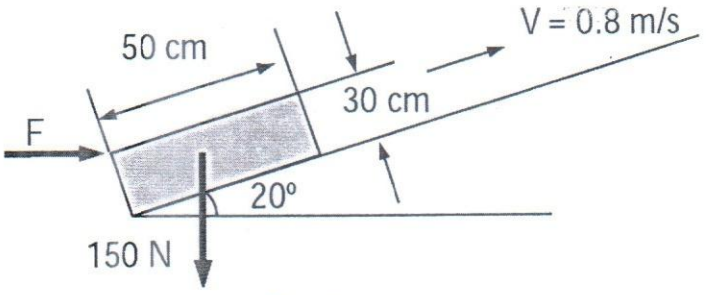

Fig. 2

2. (a) Define coefficient of compressibility and coefficient of volume expansion. **[06]**

(b) What is Hydrostatics? Determine the resultant hydrostatic force acting on the surface and the line of action considering a flat plate completely submerged in a liquid. **[11]**

(c) An oil pipeline and a 1.3 m^3 rigid air tank are connected to each other by a manometer, as shown in **Fig. 3**. If the tank contains 15 kg of air at 80°C, determine (*a*) the absolute pressure in the pipeline and (*b*) the change in Δh when the temperature in the tank drops to 20°C. Assume the pressure in the oil pipeline to remain constant, and the air volume in the manometer to be negligible relative to the volume of the tank. **[16.33]**

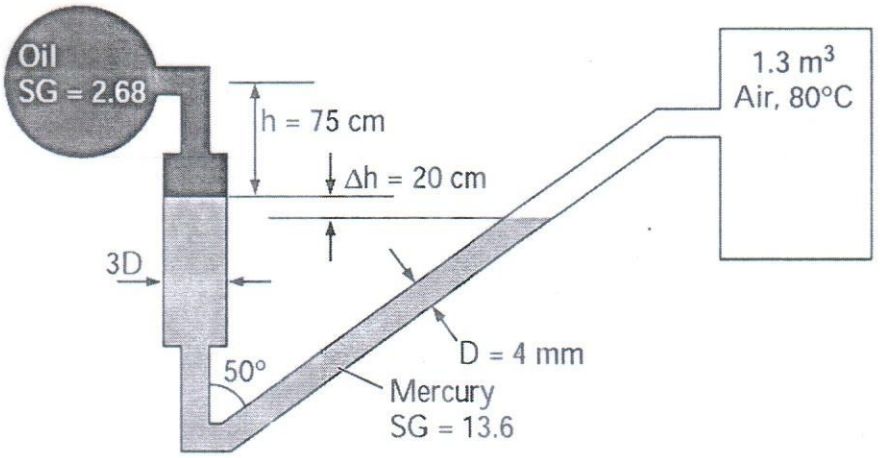

Fig. 3

3. (a) Differentiate between forced vortex motion and Capillary effect. **[06]**

(b) Derive the equation of motion for fluid that acts as a rigid body in an accelerating tanker and reduce it to surface of constant pressure during the motion on a straight Path. **[11]**

(c) A 3-m-diameter, 7-m-long cylindrical tank is completely filled with water. The tank is pulled by a truck on a level road with the 7-m-long axis being horizontal **(Fig. 4)**. Determine the pressure difference between the front and back ends of the tank along a horizontal line when the truck (*a*) accelerates at 3 m/s^2 and (*b*) decelerates at 4 m/s^2. **[16.33]**

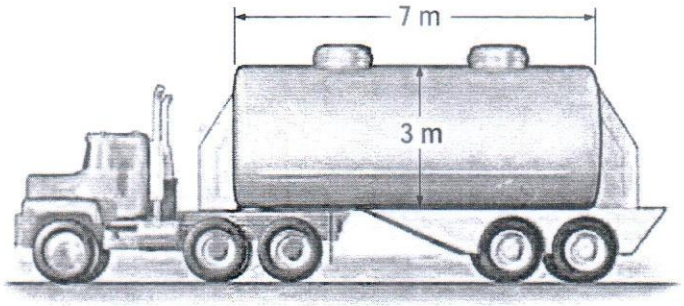

Fig. 4

4. (a) Discuss the stability of (a) a submerged and (b) a floating body whose center of gravity is above the center of buoyancy. **[06]**

(b) What is Conservation of Energy Principle? Derive an expression for continuity equation in unsteady, compressible flow for three dimensional coordinate system. **[11]**

(c) A horizontal pipeline is attached to the wall of reservoir as shown in **Fig. 5**. 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 EGL and HGL. **[16.33]**

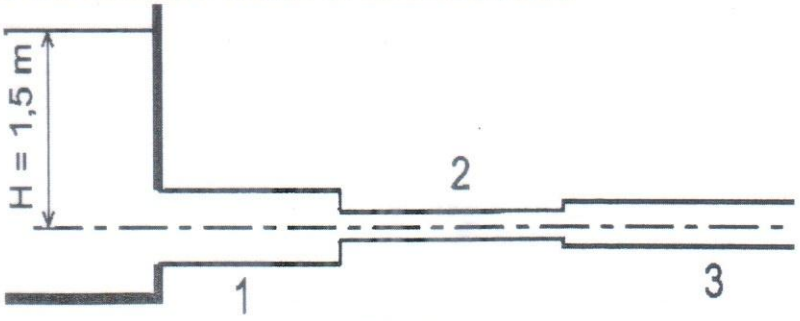

Fig. 5

B Sc. Eng. (ME),(3rd Sem.)/B Sc TE (2 Year, 1st Sem.) 02 March, 2020(Morning)

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

Mid Semester Examination — Winter Semester, A.Y. 2019-2020
Course Code: Math 4311/4599 — Time : $1\frac{1}{2}$ hours
Course Title: Vector Analysis — Full Marks: 75

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

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1. a) Show that the three vectors A = 2i + j - 3k, B = i - 4k and C = 4i + 3j - k are linearly dependent. Determine a relation among them and hence show that the terminal points are collinear.

   b) Evaluate $\iint_S \mathbf{F}.\mathbf{n}\, dS$ where $F = 3x\mathbf{i} + 4y\mathbf{j} + 2z\mathbf{k}$ and S is surface of the plane 2x + 3y + z = 6 which lies in the first octant.

2. a) Find the moment about a line through the origin having direction of $2\boldsymbol{i} - 2\boldsymbol{j} + 7\boldsymbol{k}$ due to a 40 kg force acting at a point (3, -5, 2) in the direction $3\boldsymbol{i} + 5\boldsymbol{j} + 4\boldsymbol{k}$.

   b) Three vectors of magnitudes p, $2p$, $4p$ meet in a point and their directions are along the diagonals of the adjacent faces of a cube. Determine their resultant and its direction cosines (dcs).

   c) Find the work done by the force field F on a particle that moves it along the curve C for $\mathbf{F} = (x+y)\mathbf{i} + xy\mathbf{j} - z^2\mathbf{k}$ where C represents the line segments from (0, 0, 0) to (1, 3, 1), then to (2,−1, 4).

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

   b) State and prove **Frenet-Serret Formula**.

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

4. a) If $p = \boldsymbol{A}\cos kt + \boldsymbol{B}\sin kt$, where $\boldsymbol{A}$ and $\boldsymbol{B}$ are constant vectors and k is a constant scalar, then find the value of $\frac{d^2\mathbf{p}}{dt^2} + k^2\mathbf{p}$.

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

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

B.Sc. Engg. (ME) (3rd Sem) 27 February 2020 (Morning)

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

Mid Semester Examination — Winter Semester, A.Y. 2019-2020
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 do you mean by bulk deformation processes? Classify the different types of rolling processes used in Manufacturing industries and hence explain the four high rolling mill and ring rolling process with necessary diagram.	17
	b)	What is forging? List the different forging processes and write down the differences between open die hammering forging processes and impression die forging processes.	16.33
2	a)	Write a short note on wire drawing forming process and spinning process.	10
	b)	Write down the differences between thermosetting and thermoplastics. What will be the fabrication techniques that may be adopted for the production of the plastic products like camera cases, door knob; light switches etc. and hence explain the manufacturing techniques with necessary diagram?	16
	c)	List the different types of thermoplastic mentioning its properties with application.	7.33
3	a)	What do you mean by sintering? Explain the effects of sintering in compacted powder product on a microscopic scale.	10
	b)	Write a short note with necessary diagram on powder rolling process and powder extrusion process used for producing the powder metallurgy products.	14
	c)	What is hot working process? Write down the advantages and disadvantages of hot working process.	9.33
4	a)	What is pattern? How the material of pattern is selected? List the different types of pattern allowance and explain the necessary diagram the different types of pattern used in casting processes.	16
	b)	Explain the necessary diagram the different components used in sand casting process and hence explain the steps in sand casting processes.	17.33

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BBA (TM)/3rd Sem. 27 February 2020 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

MiD SEMESTER EXAMINATION
Course No: MCE 4361
Course Name: Mechanical Technology-I

WINTER SEMESTER: 2019-2020
TIME : 1HR 30 MINS
FULL MARKS: 75

There are **Four** Questions. Answer any **Three** Questions. All questions carry equal marks. Please refer to the attached Tables for required thermodynamic properties and assume reasonable value for missing data.

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1 **(a)** Provide the extensive explanation for the phase-change processes of pure substances with labelled schematic diagrams. Draw and explain a **T-v** diagram for the heating process of water at constant pressure. 15

(b) A piston cylinder device contains **0.85 kg** of refrigerant **134-a** at **-10 ^{0}C**. The piston that is free to move has a mass of **10 kg** and a diameter of **25 Cm**. The local atmospheric pressure is **88 kPa**. Now the heat is transferred to the refrigerant until the temperature is **15 ^{0}C**. Determine **i)** the final pressure **ii)** the change in volume of the cylinder, and **iii)** the change in the enthalpy of **R-134a**. 10

2 **(a)** How the segregation of Boiler is adopted. Explain the operational principle of longitudinal drum horizontal straight tube boiler with the labelled schematic diagram. 10

(b) Provide an adequate explanation for the Carnot Vapor Cycle with **T-s** diagram and signify all the necessary thermodynamic devices incorporated in this cycle. 5

(c) A simple ideal Rankine cycle (provided in **Figure 2c**) which uses water as the working fluid operates its condenser at **40^{0}C** and its boiler at **300^{0}C**. Calculate the work produced by the turbine,the heat supplied in the boiler, and the thermal efficiency of this cycle when the steam enters the turbine without any superheating. 15

3 **(a)** Clarify and briefly explain the prominent differences between the ideal Rankine cycle and ideal Reheat Rankine cycle with **T-s** diagrams. 7

(b) Consider a steam power plant that operates on theideal reheat Rankine cycle shown in **Figure 3b**. The plant maintains the boiler at **5000 kPa**, the reheat section at **1200 kPa**, and the condenser at **20 kPa**. The mixture quality at the exit of both turbines is **96** percent. Determine the temperature at the inlet of each turbine and the cycle's thermal efficiency. 18

4 **(a)** Write down and briefly explain the crucial characteristics of refrigerant which needs to 5

be looked at while designing a refrigeration system.

(b) Briefly explain the working principle of reversed Carnot Cycle with schematic of a Carnot refrigerator and **T-s** diagram. 5

(c) An ideal vapor-compression refrigeration cycle (given in **Figure 4c**) that uses refrigerant-**134a** as its working fluid maintains a condenser at **800 kPa** and the evaporator at **212^{0}C**. Determine this system's **COP** and the amount of power required to service a **150 kW** cooling load. 15

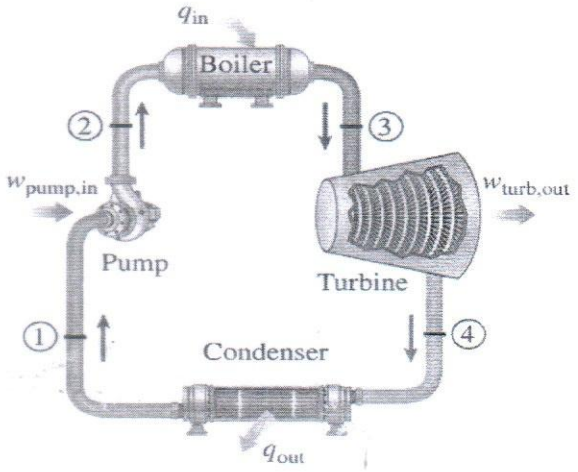

Figure 2c

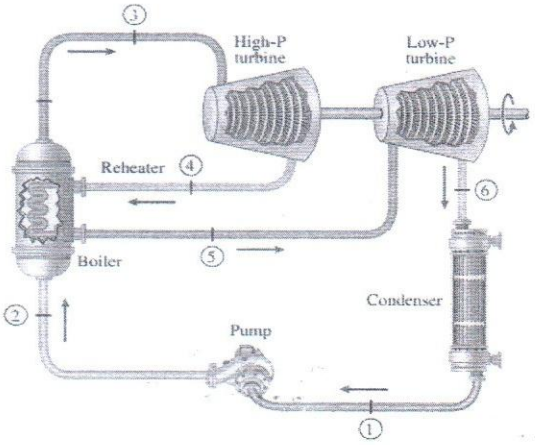

Figure 3b

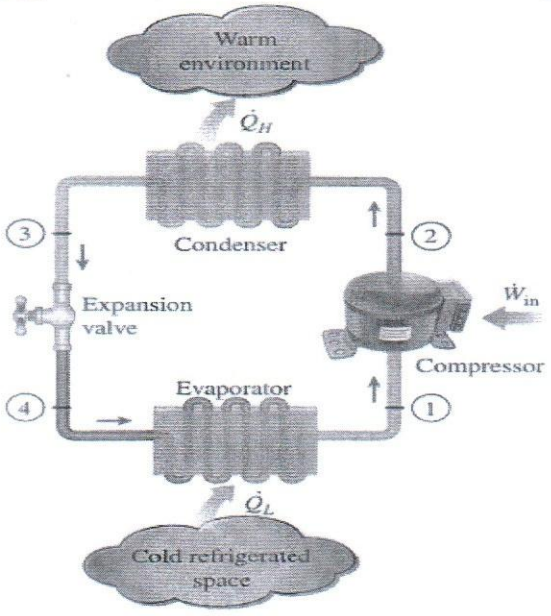

Figure 4c

B.Sc. Engg. (EEE)/3rd Sem

28 February, 2020 (Afternoon)

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

Mid Semester Examination
Course No.: MCE 4391
Course Title: Basic Mechanical Engineering

Winter Semester, A. Y. 2019-2020
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) Using the schematic diagram of a Pelton Wheel describe its working principle. 11

b) Define specific speed of the turbine. What is the importance of it? 6

c) A turbine is designed to deliver 695 KW with a head of 50 meters operating at 75 revolutions per minute. Suggest the type of turbine that would be suitable. 8

2 a) Describe stance phase of a gait cycle. 8

b) What are the uses of goniometer and accelerometer to analyze gait cycle? 5

c) The mass distribution of the body of a man with 65 kg is the following: head plus neck (5.0 kg), each arm-forearm-hand (3.5 kg), torso (37 kg), each thigh (6.5 kg), and each leg plus foot (4.0 kg). Consider that this person is standing upright on both feet, find the intensity of the normal force (of contact): 12

(i) exerted at each of the hip joints and
(ii) exerted at each of the knee joints.

Consider now that the man is standing on one foot, find the intensity of the contact force:
(iii) in the knee joint of the leg by which the man is supported and
(iv) in the knee joint that supports the leg that is off the floor.

3 a) What is fuel? Write down the requirements of a good fuel? 07

b) What is meant by thermodynamic equilibrium? What are the first law and second law of thermodynamics? 08

c) A Carnot heat engine receives 500 kJ of heat from a high-temperature source at 600°C and rejects heat to a low-temperature sink at 30°C. Determine the (a) thermal efficiency of this heat engine and (b) amount of heat rejected from the sink per cycle. 10

4 a) What is boiler? Write the difference between the boiler mountings and accessories? 07

b) With necessary sketches, describe the working processes of a diesel cycle. 08

c) In an air standard Otto cycle, the compression ratio is 7 and the compression begins at 30°C and 0.15 MPa. The maximum temperature of the cycle is 1200°C. Find (a) the temperature and the pressure at various points in the cycle, (b) the heat supplied per kg of air, (c) the work done per kg of air, (d) the cycle efficiency and (e) the MEP of the cycle. 10

BSc. Eng. (M)/ HDME/ 5th Sem. **03 March 2020**
BScTE(2 Yr.)/ 1st Sem. **(Morning)**

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

Mid Semester Examination — Winter Semester: A.Y. 2019-2020
Course Code: MCE 4503/MCE 4595 — Time : 1.5 hours
Course Title: Mechanics of Machines — Full Marks : 75

There are **4** Questions. Answer **3** of them. **Answering of question number 1 is compulsory.**
Figures in the right margin indicate the full marks. Assume reasonable data if necessary.
Don't write on this question paper.

1 a) A sketch of a front loader is shown in Fig. 1. Draw a *kinematic diagram* of the mechanism. (7)

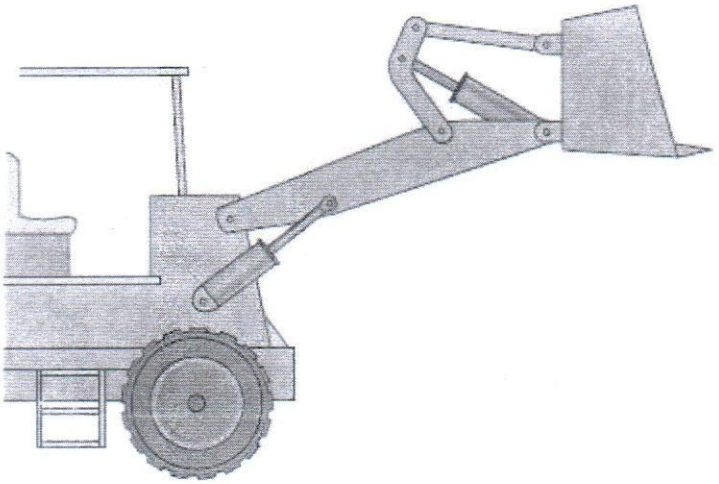

Fig. 1

b) Determine the *mobility* associated with the mechanism in Fig. 2. (12)

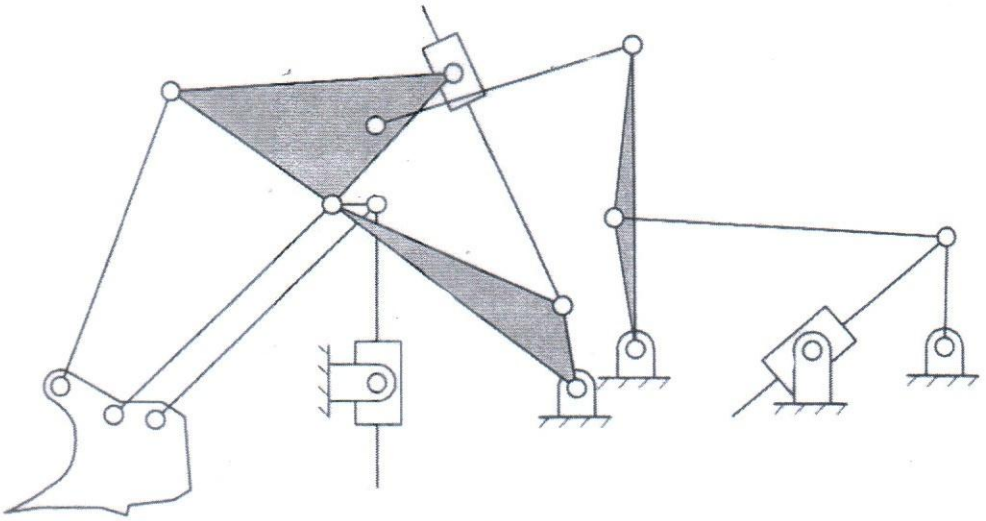

Fig. 2

c) Write short note on *Grashof* and *non-Grashof* mechanism. (6)

2 In the mechanism shown in Fig. 3 (page 3), link 2 is rotating CW at the rate of 4 rad/s (constant). In the position shown, θ is 53°. Write the appropriate *vector equations*, solve them using *vector polygons*, and (25)

a) Determine $\boldsymbol{v}_{C4}$, $\boldsymbol{\omega}_3$, and $\boldsymbol{\omega}_4$.

b) Determine $\boldsymbol{a}_{C4}$, $\boldsymbol{\alpha}_3$, and $\boldsymbol{\alpha}_4$.

Link lengths: AB = 100 mm, BC = 160 mm, CD = 200 mm.
You can solve the problem on that figure and attach it with your script.

3. Design a fourbar mechanism to give the two positions shown in Fig.4 (page 4) of coupler motion. Add a driver dyad. (25)
Solve the problem on that figure and attach it with your script.

4. Forming the *vector loop* equation for the fourbar linkage shown in following Fig. 5, solve for the unknown angles θ_4, θ_3. (25)

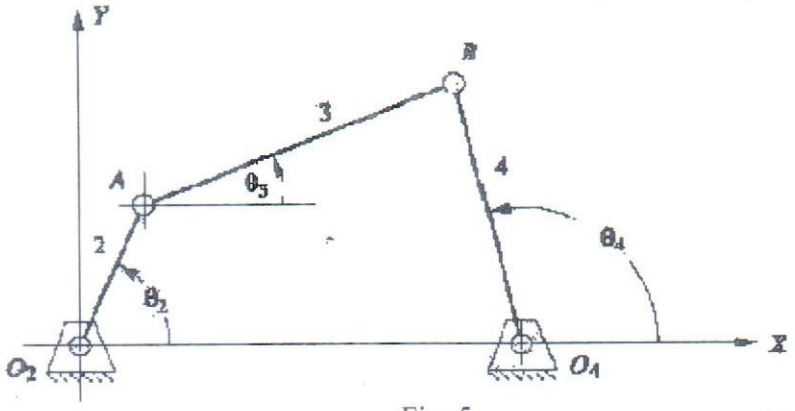

Fig. 5

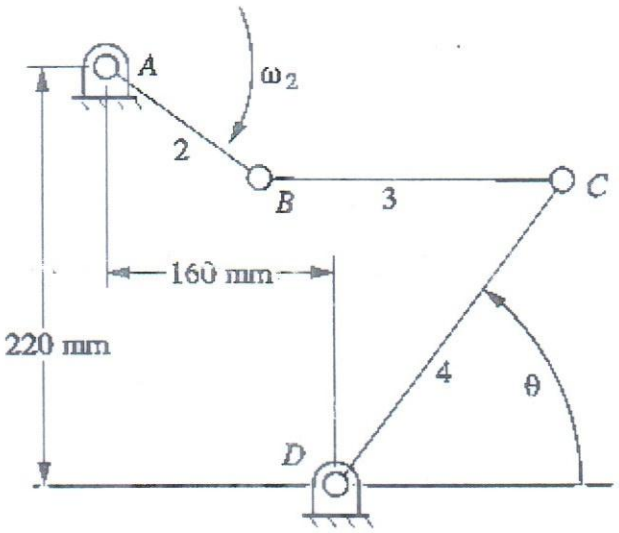

Fig. 3

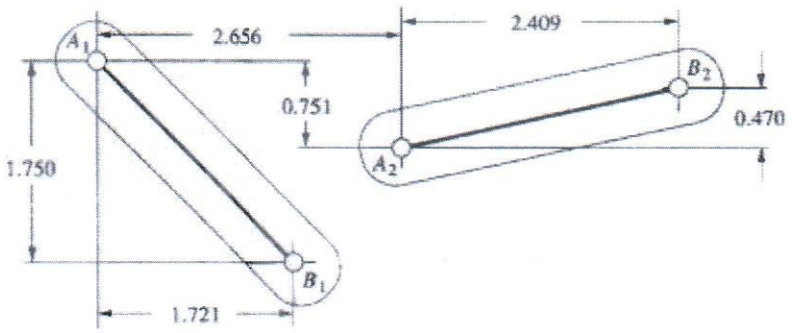

Fig. 4

B.Sc. Eng. (M) /5th Sem. 27 February 2020 (Morning)
HDME/5th Sem.
B.Sc. TE/ 1st Sem. (2 Yr.)

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

Mid Semester Examination — Winter Semester: A.Y. 2019-2020
Course Code: MCE 4507/MCE 4593 — Time : $1\frac{1}{2}$ Hours
Course Title: Control and Automation — Full Marks : 50

There are 3 (three) questions. Answer any 4 (four) questions.
Assume any missing data. Do not write on the question paper.

1. **a)** Write down the advantages of fluid power system? [5]

   b) Find the total force for synchronizing circuit where cylinders are connected in series. [5]

   c) A hydraulic motor has a displacement of 164 cm^3 and operates with a pressure of 70 bars and a speed of 2000 rpm. If the actual flow rate consumed by the motor is 0.006 m^3/s and the actual torque delivered by the motor is 170 Nm. Find [$6\frac{2}{3}$]
   i. Mechanical efficiency.
   ii. Volumetric efficiency.
   iii. Overall efficiency.
   iv. The actual power delivered by the motor.

2. **a)** Explain briefly the advantages of positive displacement pumps over non positive displacement pumps. [5]

   b) The 2700 kg weight is to be lifted upward in a vertical direction. Find the cylinder force required to [5]
   i. Move the weight at a constant velocity of 2.5 m/s.
   ii. Acceleration the weight from zero velocity to a velocity of 2.5 m/s in 0.50s.

   c) Derive the volumetric displacement of vane pump. Draw the pressure versus flow diagram for vane pump. [$6\frac{2}{3}$]

3. **a)** Draw a hydraulic system consist of tank, filter, pump, pressure relief valve, 4 way and 3 position spring return, solenoid actuated valve, double acting cylinder. [$6\frac{2}{3}$]

   b) What is Filter regulator lubricator (FRL) in pneumatic system? Draw its ANSI symbol. [5]

   c) For the meter-in flow control valve system figure 1, the following data are given: desired cylinder speed = 10 in/s, cylinder piston diameter = 2in, cylinder load = 3000 lb. specific gravity of oil = 0.90 pressure relief valve setting = 1000 psi. Determine the required capacity coefficient of the flow control valve. [5]

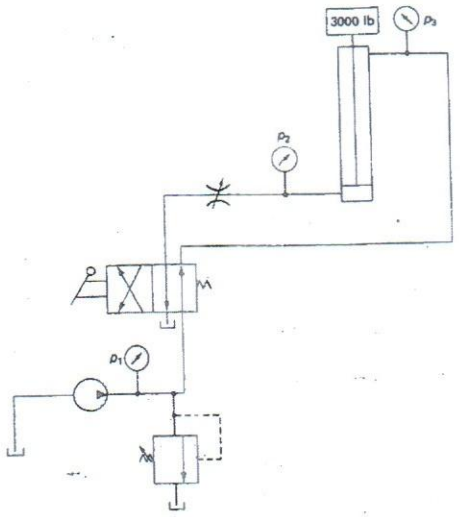

Figure 1

4. **a)** Explain gear motor's working principle with proper diagram. [5]

   b) A pressure relief valve (PRV) contains a poppet with a 4.2 cm^2 area on which system pressure acts. During assembly a spring with a spring constant of 3200N/cm^2 is installed in the valve to hold the poppet against its seat. The adjustment mechanism is then set so that the spring is initially compressed 0.50 cm from its free-length condition. In order to pass full pump flow through the valve at the PRV pressure setting, the poppet must move 0.30 cm from its fully closed position. Determine the [5]

   i. Cracking pressure

   ii. Fully pump flow pressure (PRV pressure setting)

   c) For a pneumatic system, write down the working principle for single acting and double acting cylinder with proper circuit diagram. [$6\frac{2}{3}$]

B.Sc. Engg. (ME)/HDME/ 5th Sem. 28 February 2020 (Morning)

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

Mid Semester Examination — Winter Semester, A. Y. 2019-2020
Course No Math 4511 — Time: 1½ Hours
Course Title: Statistics and Quality Control — Full Marks: 75

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

Marks in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper. Standardized normal probability charts are provided at the end of the question.

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

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

i. Make the data into appropriate classes and then prepare a frequency table.
ii. Determine the Range, Mean, Median, Mode and Standard Deviation from grouped data.
iii. Draw a stem and leaf diagram.

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

Causes	*Frequency*
Oil leakage	65
Human error	16
Cooling failure	15
Initiator System	25
Interlock malfunction	19
Heat Exchanger error	75

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

b) The average grade for an exam is 68, and the standard deviation is 8. If 15% of The class is given A, and the grades are curved to follow a normal distribution, What is the lowest possible A and the highest possible B? 5

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

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

b) Gauges are used to reject all components for which a certain dimension is not within the specification $1.50 \pm d$. It is known that this measurement is normally distributed with mean1.50 and standard deviation 0.2. Determine the value d such that the specifications "cover" 99% of the measurements 10

c) Mention two essential requirements while drawing cause and effect diagram. Then draw a cause and effect (Ishikawa) diagram for the large no of faulty cars produced by your car manufacturing company . 7

4. a) A student in public administration wants to determine the mean amount members of city councils in large cities earn per month as remuneration for being a council member. The error in estimating the mean is to be less than $100 with a 98 percent level of confidence. The student found a report by the Department of Labor that estimated the standard deviation to be $1,000. What is the required sample size? 6

b) What do you understand by sampling? Describe stratified and cluster sampling methods with examples. 12

c) The union representing the Bottle Blowers of Argentina (BBA) is considering a proposal to merge with the Truck Drivers Union. According to BBA union bylaws, at least three-fourths of the union membership must approve any merger. A random sample of 2,000 current BBA members reveals 1,500 plan to vote for the merger proposal. What is the estimate of the population proportion? Develop a 95 percent confidence interval for the population proportion. Basing your decision on this sample information, can you conclude that the necessary proportion of BBA members favor the merger? Why? Give reasons. 7

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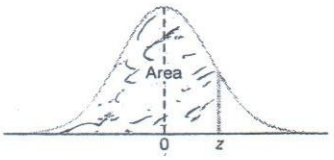
Table A.3 Areas under the Normal Curve



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

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

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

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

Mid Semester Examination — Winter Semester, A.Y. 2019-2020
Course Code: Hum 4521 — Time : $1\frac{1}{2}$ hours
Course Title: Engineering Management — Full Marks : 75

There are 4 (Four) Questions. Answer any 3 (three) of them.
Programmable calculators are not allowed. Do not write on the question paper

1 a) What is engineering management? Specify its scope in a modern society. 4

b) What are the six management theories? Brifely describe the 14 principles of Management developed by Henri Fayol. 8

c) What are the general building blocks of organizational structures? How do you illustrate the common specific management structure? 8

d) What are the advantages and disadvantages of matri sturctures? 5

2 a) Illustarte the ways to improve communication with your employees. 4

b) What are the functions of engineering management? Brifely illustrate these functions in managing an internationally reputed organization. 8

c) What are the types of organizational objectives in the modern shoe industries? Illustarte your answer with exaamples. 8

d) What is job intruction, training? Brifely describe the four basic steps for the job instruction training. 5

3 a) The number of heart surgeries performed at Heartville General Hospital has increased steadily over the past several years. The hospital's administration is seeking the best method to forecast the demand for such surgeries in year 6. The data for the past 5 years are shown. 17

Year	Demand
1	45
2	50
3	52
4	56
5	8

The hospital's administration is considering the following forecasting methods.

i. Exponential smoothing, with $\alpha = 0.6$. Let the initial forecast for year 1 be 45, the same as the actual demand.
ii. Exponential smoothing, with $\alpha = 0.9$. Let the initial forecast for year 1 be 45, the same as the actual demand.
iii. Two year moving average.
iv. Two year weighted moving average, using weights 0.6 and 0.4, with more recent data given more weight.
v. Regression model $y = 42.6 + 3.2x$, where y is the number of surgeries and x is the index for the year (e.g., $x = 1$ for year 1, $x = 2$ for year 2, and so forth).
vi. If MAD is the performance criteria chosen by the administration, which forecasting method should it choose?

b) What is Feedback control system in the transformation process? Explain with a suitable example. 4

c) What are the typical operations management decisions involve that can have impact on cost or profit? Explain. 4

4 a) The President, Chip Monk, of the Tim Burr Company wants to best utilize the wood resources in one of its forest regions. Within this region, there is a saw mill and a plywood mill; thus timber can be converted to lumber or plywood. Producing marketable mix of 1,000 broad feet of lumber products requires 1,000 broad feet of spruce and 4,000 broad feet of Douglas fir. Producing 1,000 square feet of plywood requires 2,000 broad feet spruce and 4,000 broad feet of Douglas fir. This region has available 32,000 broad feet of spruce and 72,000 broad feet of Douglas fir.
Sales commitments require that at least 5,000 broad feet of lumber 12,000 square feet of plywood be produced during the planning period. The profit contributions are \$45 per 1,000 broad feet of lumber products and \$60 per 1,000 square feet of plywood. Express the problem as a linear programming model. 10

b) Objective function: 11

Maximize $z = x_1 + 0.5x_2$

Constrains:

$3x_1 + 2x_2 \leq 12$

$5x_1 \leq 10$

$x_1 + x_2 \leq 8$

$-x_1 + x_2 \geq 4$

$x_1, x_2 \geq 0$

i. Find the feasible area by Graphical Method.
ii. Find the optimum value of x_1 and x_2.
iii. Find the maximum profit
iv. Find the range of optimality for x_1 and x_2.

c) Discuss the effect of inaccurate forecasting in any business organization. 4

B.Sc. Engg. (M)/5th Sem. (Prod.) 24 February 2020 (Morn.)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

THE ORGANIZATION OF THE ISLAMIC CONFERENCE (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

MID SEMESTER EXAMINATION WINTER SEMESTER: 2019-2020

COURSE NO. MCE 4521 TIME: 1 ½ HRS

COURSE TITLE: Materials Engineering FULL MARKS: 75

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

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

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

   (c) Calculate the tensile strength of the low carbon steel rod. (03)

2. (a) Distinguish between annealing and normalizing. Mention at least three advantages of each. (10)

   (b) "Normalized mild steel shows finer grain size than annealed mild steel." Explain in detail how the grain size becomes finer in normalized steel. (09)

   (c) Draw the microstructure of a mild steel rod both in annealed and normalized conditions. Which steel is stronger and why? (06)

3. (a) Distinguish between bainite and martensite. Give an outline of the formation of martensite. (10)

   (b) Draw the I.T. diagram for a hypereutectoid steel and label the diagram completely. Show the continuous cooling curve superimposed on the I.T. diagram to produce a microstructure consisting of:

   (i) Cementite+Pearlite, (ii) Martensite, (iii) Bainite, (iv) Cementite+Pearlite + Bainite + Martensite and (v) Bainite + Martensite. (15)

4. (a) "Hardening a high carbon steel part by quenching is almost immediately followed by tempering" – justify. (8)

   (b) Describe the effect of tempering temperature on the hardness, toughness, and microstructure of a quenched high carbon steel part. (17)

B.Sc. Eng. (CSE)/ 5th Sem. 03 March, 2020 (Morning)

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

Mid Semester Examination — Winter Semester: 2019-2020
COURSE NO.: Math-4541 — TIME : 1½ Hours
COURSE TITLE: Multivariable Calculus and Complex Variables — FULL MARKS: 75

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

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1. a) (i) Let z_1, z_2, z_3 represent vertices of an equilateral triangle. Prove that **12**

$$z_1^2 + z_2^2 + z_3^2 = z_1z_2 + z_2z_3 + z_3z_1$$

(ii) An airplane travels 150 miles southeast, 100 miles due west, 225 miles 30^0 north of east, and then 200 miles northeast. Determine by the concept of polar form of a complex number (a) analytically and (b) graphically how far and in what direction it is from its starting point.

b) (i) Find an equation using the complex number system for (a) a circle of radius 4 with center at (2, 1), (b) an ellipse with major axis of length 10 and foci at (3, 0) and (3, 0). **13**

(ii) State De Moivre's Theorem and using this theorem prove that

$$\cos 5\theta = 16\cos^5\theta - 20\cos^3\theta + 5\cos\theta$$

2. a) Find each of the indicated roots and locate them graphically **12**

$$(i)\ (-1+i)^{1/3}\ \ (ii)\left(-2\sqrt{3}-2i\right)^{1/4}$$

b) Solve the equation: **13**

$$(i)z^2 + (2i-3)z + 5 - i = 0\ \ (ii)\ z^5 = 1$$

3. a) Consider the transformation $w = \ln z$. **12**

Show that

(i) circles with center at the origin in the z plane are mapped into lines parallel to the v axis in the w plane.

(ii) lines or rays emanating from the origin in the z plane are mapped into lines parallel to the u axis in the w plane.

(iii) the z plane is mapped into a strip of width 2π in the w plane. Illustrate the results graphically.

b) (i) Suppose the principal branch of $\sin^{-1} z$ to be that one for which $\sin^{-1} 0 = 0$. **13**

Prove that $\sin^{-1} z = \frac{1}{i}\ln\left(iz + \sqrt{1-z^2}\right)$

(ii) Prove that $f(z) = z^2$ is uniformly continuous in the region $|z| < 1$

4. a) (i) Write necessary and sufficient conditions of $f(z) = u(x,y) + v(x,y)i$ be analytic in a region R. **12**

(ii) Prove that $u = 3x^2y + 2x^2 - y^3 - 2y^2$ is harmonic and Find v such that $f(z) = u + iv$ is analytic.

b) Locate and name all the singularities of $f(z) = \dfrac{z^8 + z^4 + 2}{(z-1)^3(3z+2)^2}$ 13

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

02 March 2020 (Morning)

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

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

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

Winter Semester, A. Y. 2019-2020
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 are the major four steps in the design and manufacturing of a mechanical product? In these four steps, which one uses CAD tool, which one uses CAE tool, and which one uses CAM tool? 15

   b) What is parallel projection? Classify the different types of parallel projection and explain briefly with necessary diagram. 10

2. a) Corresponding to the viewpoint $(-10,0,1)$, the viewsite $(0,0,1)$, and the up vector $(0,0,1)$, the viewing coordinate system is drawn as shown in the accompanying Figure 1. Note that all the coordinate and component values are given in world coordinates. From the relative position between the viewing coordinate system and the world coordinate system, (i) calculate the mapping transformation $\boldsymbol{T}_{w-v}$ and (ii) calculate the coordinates of a point in viewing coordinates if it has world coordinates $(5,0,1)$. 15

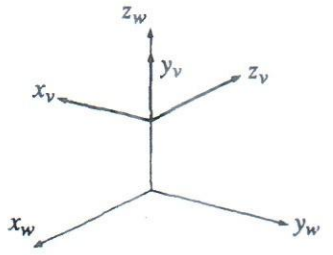

Figure 1

   b) Describe the steps involve in changing a coordinate from model coordinate system to device coordinate system. 10

3. a) What is Wireframe and Surface modeling systems? Write down their advantages and disadvantages. 13

   b) Write down the steps of constructing the skin surface over a circle and a square. 12

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) Write down the drawbacks of Bezier Curve. 5

BSc. Engg. (M) 5th Sem/DTE 1st Sem — 02 March 2020 (Morning)

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

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

MID SEMESTER EXAMINATION — Winter Semester: 2019-2020
Course No: MCE-4551 — TIME : $1^1/_2$ HRS
Course Name: Refrigeration — FULL MARKS: 75

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

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1. a) Draw the actual vapour compression refrigeration cycle on a p-h diagram, identifying the processes. (10)

   b) An ideal vapor-compression heat pump cycle with **refrigerant-134a** as the working fluid provides **15 kW** to maintain a building at **20°C** when the outside temperature is **5°C.** Saturated vapor at **2.4 bar** leaves the evaporator, and saturated liquid at **8 bar** leaves the condenser. Calculate (a) The power input to the compressor, in kW (b) The coefficient of performance. (c) The coefficient of performance of a reversible heat pump cycle operating between thermal reservoirs at **20°C** and **5°C.** (15)

2. a) Explain the effect of suction and discharge pressure on Vapour Compression Refrigeration (VCR) cycle with appropriate diagrams. (10)

   b) Air enters the compressor of an ideal Brayton refrigeration cycle at **140 kPa, 270 K,** with a volumetric flow rate of **1 m^3 /s,** and is compressed to **420 kPa.** The temperature at the turbine inlet is **320 K.** Determine (a) The net power input, in **kW** (b) The refrigerating capacity, in kW. (c) The coefficient of performance. (d) The coefficient of performance of a reversible refrigeration cycle operating between reservoirs at $T_C = 270$ K and $T_H = 320$ K. (15)

3. a) Explain with necessary diagram the different parts of the vapor compression refrigeration system. Show different types of VCR cycle on P-h diagram. (10)

   b) A heat pump with **refrigerant-134a** as the working fluid is used to keep a space at **25 °C** by absorbing heat from geothermal water that enters the evaporator at **60 °C** at a rate of **0.065 kg/s** and leaves at **40 °C.** Refrigerant enters the evaporator at **12°C** with a quality of **15%** and leaves at the same pressure as saturated vapor. (15)
   If the compressor consumes **1.6 kW** of power, determine (a) The mass flow rate of the refrigerant, (b) The rate of heat supply, (c) The COP, (d) The minimum power input to the compressor for the same rate of heat supply.

4. a) Derive expression for COP of VCR system using accumulator or pre-cooler. Draw the system diagram and cycle on P-h diagram. (10)

   b) **Refrigerant-134a** enters the compressor of a refrigerator at **140 kPa** and **-10°C** at a rate of **0.3 m^3/min** and leaves at **1 MPa**. The isentropic efficiency of the compressor is **78 percent**. The refrigerant enters the throttling valve at **0.95 MPa** and **30°C** and leaves the evaporator as saturated vapor at **-18.5°C.** Show the cycle on a P-h diagram with respect to saturation lines, and determine (a) the power input to the compressor, (b) the rate of heat removal from the refrigerated space, and (c) the pressure drop and rate of heat gain in the line between the evaporator and the compressor. (15)

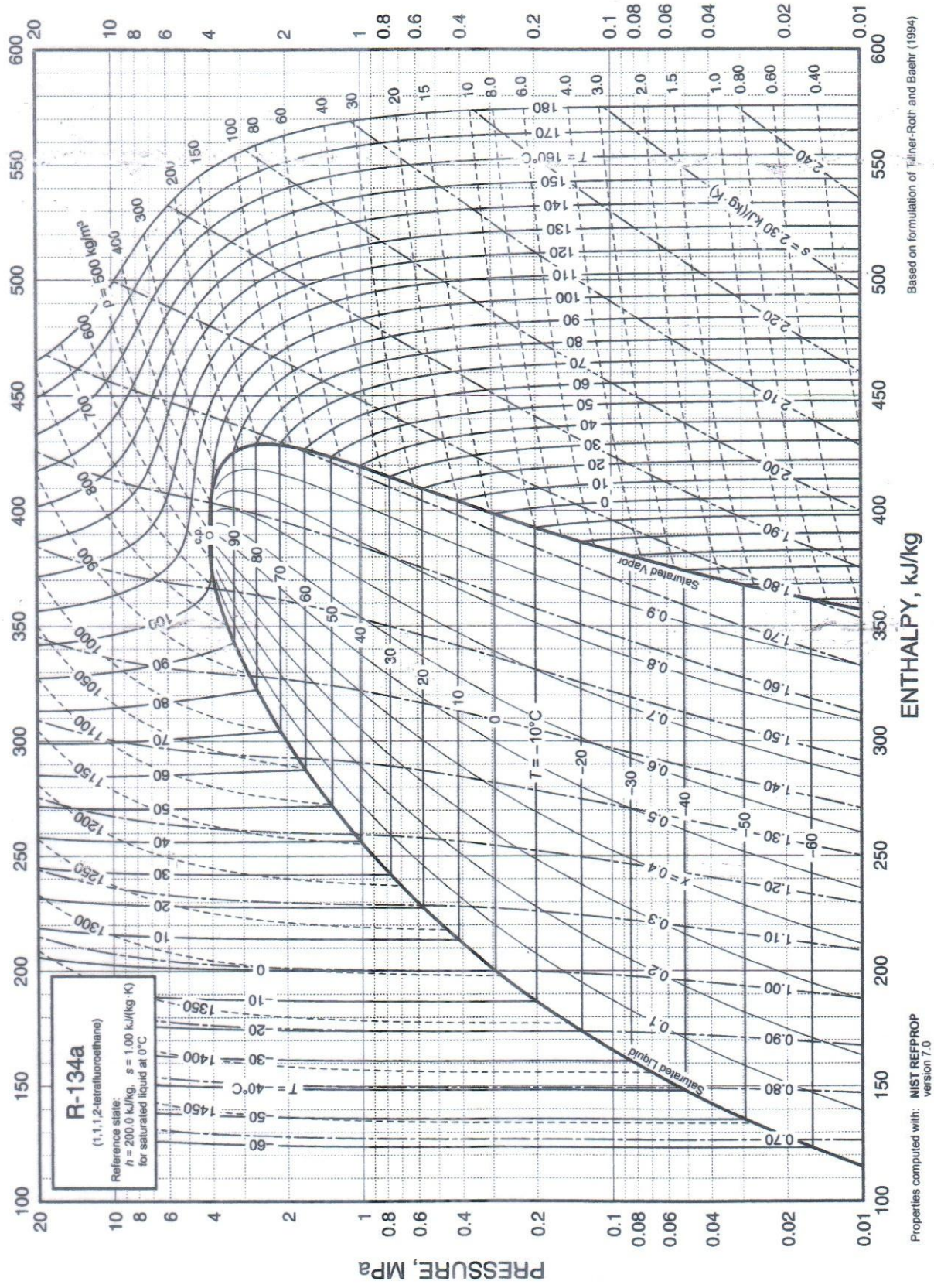

Fig. 8 Pressure-Enthalpy Diagram for Refrigerant 134a

BSc.ME (5th Semester)/DTE 1st Sem Library — 24 February,2020 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Mid SemesterExamination	Winter Semester :**A.Y. 2019-2020**
Course Code:**MCE 4573**	Time : **1.5Hours**
Course Title: **Renewable Energy Resources**	Full Marks : **75**

There are 04 (four) Questions. Answer any 03 (three) of them.

Do not write on the Question Paper. Figures in the Margin indicate the Full Marks.

Assume reasonable data if necessary. The symbols in the paper have their usual meaning.

Please turn over for the formula sheet.

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1 a) Define renewable energy and non-renewable (conventional) energy. Discuss the advantages of using renewable energy over the conventional energy. **(10)**

b) Explain the working principle of solar photovoltaic system with a neat sketch showing different components. **(8)**

c) Write a short note on Bioenergy. **(7)**

2 a) Define surface azimuth angle, angle of incidence, hour angle and profile angle. Draw neat sketches to represent these angles. **(12)**

b) Determine the solar time and solar azimuth angle for sun rise on August 1 for a location of 40° N latitude. Consider the surface as horizontal. **(13)**

3 a) Explain beam and diffuse radiation with sketches, Write an expression for ratio of beam radiation. **(8)**

b) With a neat sketch describe the working principle of a pyranometer. **(8)**

c) Explain the I-V characteristic curve of a solar cell with the effects of temperature and irradiance on it. **(9)**

4 a) Briefly explain the design criteria for wind turbines. **(8)**

b) What is Betz criterion? Derive an expression to show that the maximum power coefficient of a wind turbine is 0.59 (16/27). State all assumptions. **(17)**

Formula Sheet

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

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

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

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

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

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

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

For $\omega_s \le 81.4°$

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

and for $\omega_s > 81.4°$

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

Library

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

February 27, 2020 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING (MPE)

MID SEMESTER EXAMINATION

MCE 4703 Vibration & System Dynamics

WINTER SEMESTER: 2019-2020

TIME : 1.5 Hrs

FULL MARKS : 75

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

1. a) Determine the equivalent spring constant of the system shown in Fig.1. (5)

   b) If $\omega = 100$ rad/s and $l = 20$ cm, what is the steady-state amplitude of angular oscillation of the slender rod of mass m shown in Fig.2. Take F_0=100 N, k=2×10^5 N/m, c=30 N-s/m, L=1.1 m. and m=1.8 kg. (20)

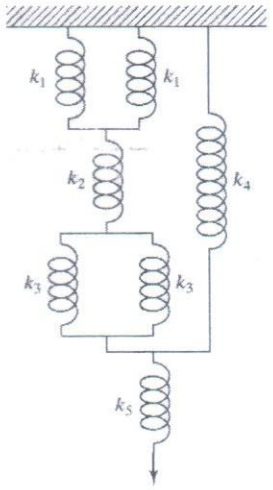

Fig.1

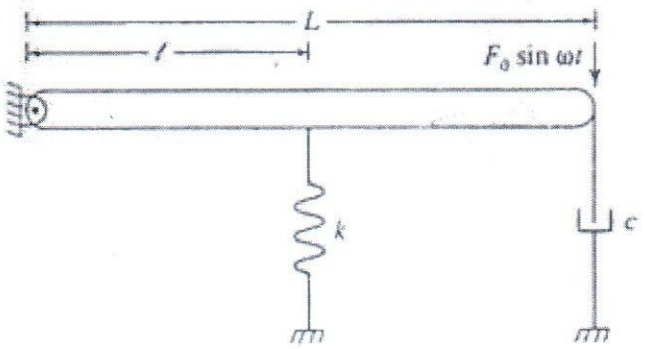

Fig.2

2. a) A 200-kg block is attached to a spring of stiffness 50,000 N/m in parallel with a viscous damper. The period of free vibration of this system is observed as 0.417 s. What is the value of the damping coefficient? (12)

   b) Determine the natural frequency for small oscillation of the thin solid disc having mass m shown in Fig.3 using the Energy method. (13)

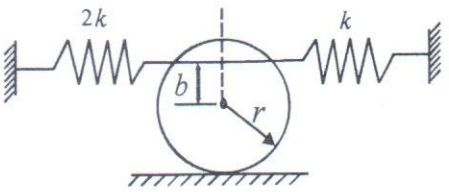

Fig.3

3. a) A simple pendulum of Length L having mass m is pivoted to the mass M which slides without friction on a horizontal plane shown in Fig.4. Derive the equations of motion of the system shown in Fig.4 for small oscillation. (12)

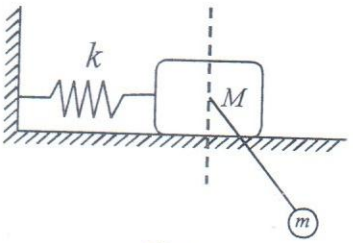

Fig.4

b) A weightless stiff rod of length $2L$ is pivoted at its center and is restrained to move in the vertical plane by spring and masses at each end shown in Fig.5. Derive the equations of motion for small oscillation using the Lagrange's equation. (13)

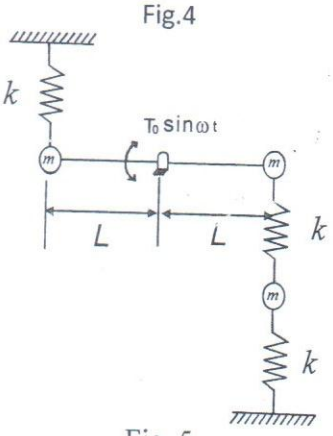

Fig. 5

4. A centrifugal pump is driven through a pair of spur wheels from an oil engine. The pump runs at 4 times the speed of the engine. The shaft from the engine flywheel to the gear is 75 mm diameter and 1.2 m long, while that from the pinion to the pump is 50 mm diameter and 400 mm long. The moment of inertia are as: Flywheel = 1000 kg-m^2; Gear = 25 kg m^2; Pinion = 10 kg-m^2; and Pump impeller = 40 kg-m^2. Determine the natural frequencies of torsional oscillations of the system. Take modulus of rigidity = 84 GN/m^2 (25)

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

Mid Semester Examination — Winter Semester, A.Y. 2019-2020
Course Code: Hum 4717 — Time : 1½ Hours
Course Title: Engineering Economy and Finance — Full Marks : 75

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

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

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

b) MUK Ltd has purchased a generator unit for \$90,000. The unit has an anticipated life of 6 years and a salvage value of \$16,000. Find out schedule of depreciation and book value for each year using Double Declining Balance method and present in a table. 15

2 a) What do you understand by pay back period? A new process for manufacturing laser levels will have a first cost of \$36,000 with annual costs of \$17,000. Income associated with the new process is expected to be \$23,000 per year that starts from year 3. There is a one time overhauling cost of \$700 at year 2. What is the simple pay-back period and pay back period when i = 12% per year?. 20

b) In order to have \$85,000 four years from now for equipment replacement, a construction company plans to set aside money today in government-insured bonds. If the bonds earn interest at a rate of 12% per year, compounded continuously, how much money must the company invest? 5

3 a) Compare the alternatives shown below on the basis of their Present Worth (PW), using an interest rate of 12% per year and provide a decision about which one of them should be selected. 18

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,\$	25,000 at year 2,then increases by \$500 every year	Not Applicable	31,000 at year 3, then increases by 6% every year
Annual Revenue, \$/year	400,000	290,000	380,000
Painting cost in 3rd year, \$	Not applicable	Not applicable	1,500
Salvage value, \$	Not applicable	70,000	100,000
Life, years	3	4	6

b) Explain MARR with numerical examples. 7

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

Item	Machine P	Machine Q	Machine R
Initial Cost, $	235,000	275,000	195,000
Maintenance Cost, $	29,000 at year 3, then increases by 4% every year	27,000, at year 2, then increases by 2,100 every year	25,000 every year
Annual income, $/year	140,000	150,000	250,000
One time overhauling cost at year 4, $	9,500	Not applicable	2,000
Salvage value, $	70,000	Not Applicable	80,000
Life, years	12	5	6

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

-----OOOO-----

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

B.Sc.Eng/7th Sem.(EEE) 28 February 2020 (Afternoon)

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

Mid Semester Examination — Winter Semester, A.Y. 2019-2020
Course No. Hum 4721 — Time : 1½ hours
Course Title: Engineering Economics — Full Marks : 50

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

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1 a) Dr. Martin Luther King, Jr. said, "Intelligence plus character building is the goal of true Education". Justify the statement from Islamic point of view and recommend the role of IUT in that regard. 5

b) Suppose that an organization produces several different electronic consumer products. Looking into the engineering economic principles and product design process, state five nonmonetary factors (attributes) that may be important for a significant change in the design of the current best-selling product. $6^2/_3$

c) Who is an Engineer? Highlight the roles of engineers in an engineering business/economics project in its various stages. Use key points and a diagram. 5

2 a) Classify each of the following cost items as mainly fixed or variable or overhead costs: *Raw materials; 90 people producing two products; supplies received for general offices; utilities for production and general use; property taxes, salaries given to chief executive officer and his office staff; building and equipment insurance; sales commissions; interest on borrowed money; and depreciation.* 5

b) The fixed cost related to the production of a product is 4,000k per year. Assume that the variable cost is 1,600k and the selling price is set 2,400k for each percentage point of annual output capacity (which equals sales demand). The maximum sales per year are 240,000k (at full capacity). All money is BDT. $6^2/_3$

i. Determine the breakeven point of this situation, and
ii. Develop the mathematical expression for profit or loss in this situation as a function of demand per year (Q).

c) A company produces circuit boards used to update outdated computer equipment. The fixed cost is \$42,000 per month and the variable cost is \$53 per circuit board. Its market research department found that selling price might follow $p = \$150 - 0.02Q$. Maximum output of the plant is 4,000 units per month. 5

i. Determine the optimum demand for this product.
ii. What is the maximum profit per month?
iii. At what volumes does breakeven occur?
iv. What is the range of profitable demand?

3 a) Distinguish between usury/riba and Shariah compliant transactions. Why must you avoid riba? Give reference from The Qur'an and Ahadeeth. 5

b) One plan for repayment of Tk1 million in four years with interest at 10% per year. Complete the following table in your answer booklet. $6^2/_3$

Yr (1)	Amount owed at the beginning of yr (2)	Interest accrued for yr (3) = (2)x10%	Total amount owed at the end of yr (4) = (2) + (3)	Principal payment (5)	Total end-of-yr payment (cash flow) (6) = (3) + (5)
1					
2					
3					
4					
Total interest			Total amount repaid		

c) Suppose that Tk850,000 is borrowed now to purchase a machine at 10% nominal interest rate per year. A partial repayment of Tk255,000 is made four years from now. Draw a cash flow diagram and determine the amount that will remain to be paid. What will be the effective interest rate if the remaining amount is paid quarterly in the next year? 5

4 a) An electronic goods manufacturing company borrowed the following money (all in Tk.): 9

End of year	1	2	3	4
Cash flows	-50,000k	-60,000k	-70,000k	-80,000k

The company wishes to calculate their present equivalent using arithmetic gradient interest formulas. Show all probable cash flow diagrams. Use i=10% per year.

b) An alternative proposal of question 4a) was given by an engineer that the company should borrow \$50,000 now and another \$50,000 three years hence. The entire obligation is to be repaid at the end of 5 years. If the projected interest rates in years one and two 10%, three 12%, four and five 14%, how much will be repaid as a lump-sum amount at the end of five years? What will be the present equivalent of the total money repaid? You need not use interest tables to solve this problem. $7^2/_3$

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B. Sc Engg. (M) (7th Sem. for UTEM students) **28 February 2020 (Afternoon)**

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

THE ORGANIZATION OF THE ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

MID TERM EXAMINATION — WINTER SEMESTER: 2019-20
COURSE NO- 4721 — TIME : 1 hr 30 min
COURSE TITLE : Manufacturing System and Automation — TOTAL MARKS : 75

There are **4** questions. Answer any **3** questions.
All questions carry marks which are indicated in the right margin.

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1. (a) What are the basic elements of an automated system? List down the common manufacturing processes and their power requirements. 12

   (b) Describe the working mechanism of different control systems of an automated system. How does the positioning system in a manufacturing process work considering the open-loop case and closed-loop case? 13

2. (a) What are the typical unit operations in the process industries and discrete manufacturing industries? 7

   (b) Briefly discuss the different level of automation in the process industries and discrete manufacturing industries. 8

   (c) Compare between continuous control and discrete control systems. 10

3. What are different approaches by which the control objective is achieved in a continuous control system? With proper illustration briefly discuss each category. 25

4. (a) Write down various common measuring devices with their feature and description used in automated system. 12

   (b) Describe the procedures for converting an analog signal from the process into digital form. Consider the operation of ADC and briefly discuss the various phases during the conversion process. 13

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

28 February, 2020 (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
Course Title: Machine Design - II

Winter Semester, A.Y. 2019-2020
TIME : 1.5 Hours
Full Marks : 50

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

1. a) What is fundamental law of gearing? Describe the profiles satisfying law of gearing. Write down the advantages of involute gears. **8**

   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. **8-2/3**

2. In a conveyor system a step-down gear drive is used. The input pinion is made of 18 teeth, 5 mm module, 20° full depth teeth of hardness 340Bhn and runs at 1410 rpm. The driven gear is of hardness 280Bhn and runs with moderate shock at 470 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. **16-2/3**

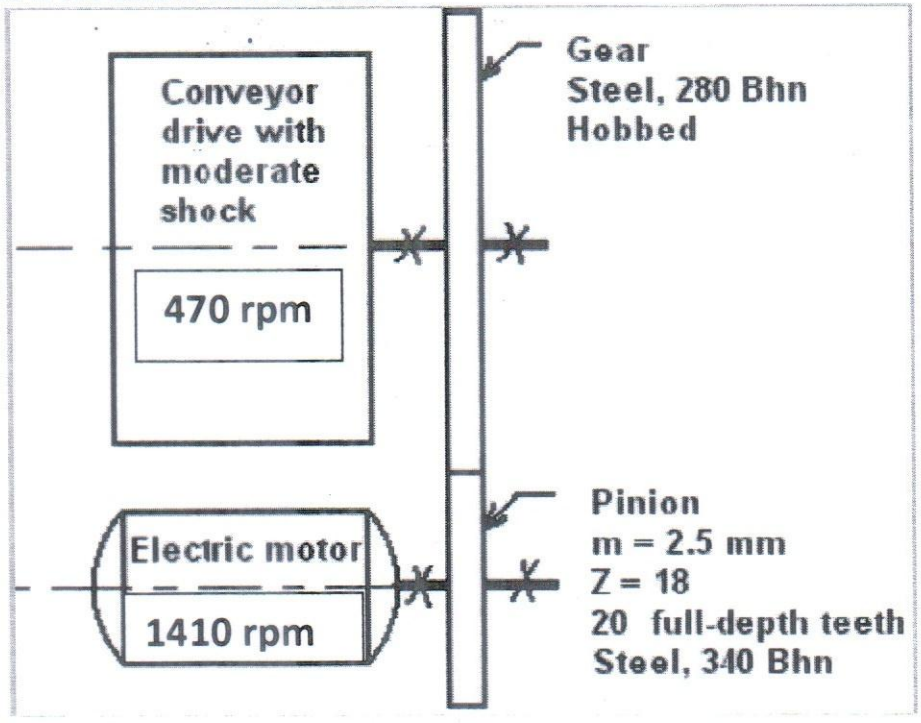


Fig. 1

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 **16-2/3**

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.

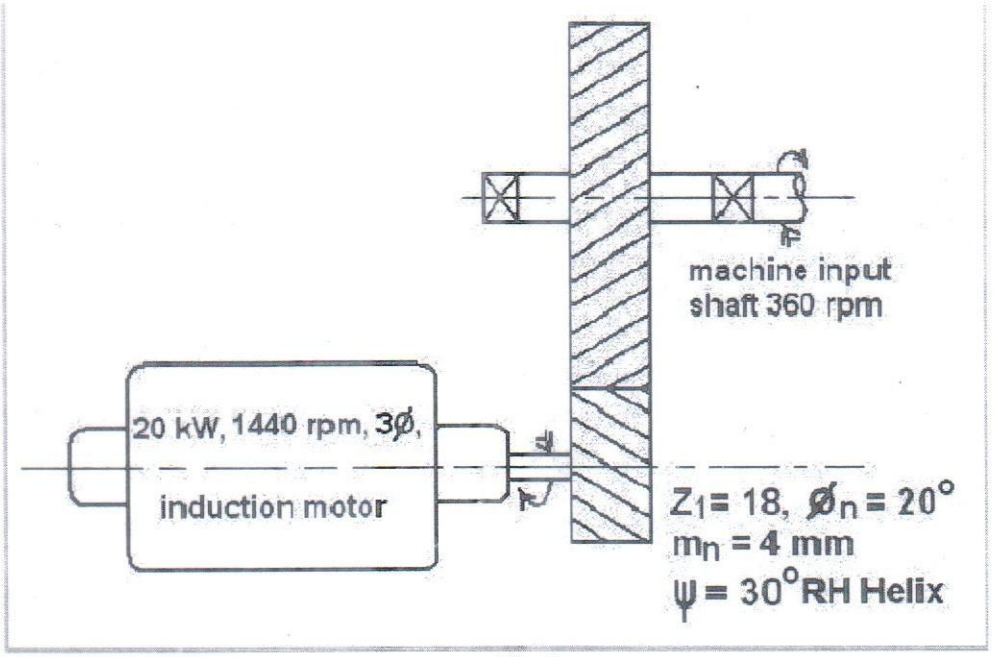


Fig.2

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. **16-2/3**

****Symbols have their usual meanings. Index 'b' is used for bending stress and 'H' is used for contact stress. Index '1' is for Pinion and '2' for Gear.**

Question No. 2 (Table 1)

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

SPUR GEAR

STANDARD MODULES IN mm:

0.3	0.4	0.5	0.6	0.7	0.8	1.0
1.25	1.5	1.75	2.0	2.25	2.5	3.0
3.5	4.0	4.5	5.0	5.5	6.0	6.5
7	8	9	10	11	12	13
14	15	16	18	20	22	24
26	28	30	33	36	39	42
45	50 Further increase is in terms of 5 mm					

Minimum number of teeth that can engage with the gear of Z_2 teeth without interference is given by,

$$z_1^2 + 2 z_1 z_2 = \frac{4k(z_2 + k)}{\sin^2 \varphi}$$

For full depth gears, k = 1.

Contact ratio, CR:

Referring to fig. 4.1, the path of contact:

$$L_a = u_a + u_r$$

$$L_a = \sqrt{(r_1 + a)^2 - r_1^2 \cos^2 \phi} + \sqrt{(r_2 + a)^2 - r_2^2 \cos^2 \phi} - (r_1 + r_2) \sin \phi$$

Now CR can be calculated with the formulae below,

$$CR = \frac{L_a}{p \cos \phi} = \frac{L_a}{\pi m \cos \phi} =$$

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

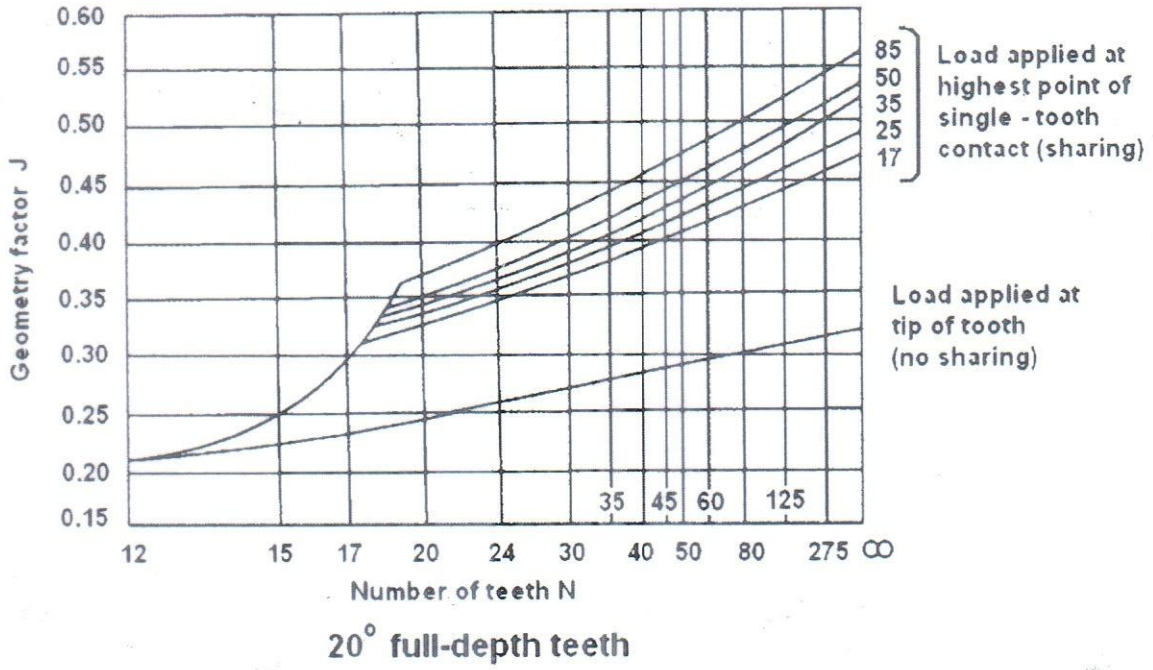


Fig.9.2 - Geometric Factor J

Table 9.3 - Overload factor K_o

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

Table 9.4 - Load distribution factor K_m

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

Bending stress is given by,

$$\sigma = \frac{F_t}{b\, m\, J} K_v\, K_o\, K_m$$

Fatigue strength of the material is given by,

$$\sigma_e = \sigma_e' \, k_L \, k_v \, k_s \, k_r \, k_T \, k_f \, k_m$$

k_L = load factor = 1.0 for bending loads

k_v = size factor = 1.0 for m < 5 mm and

= 0.85 for m > 5 mm

k_T = temperature factor = 1 for $T \leq 350^{\circ}C$

= 0.5 for $350 < T \leq 500^{\circ}C$

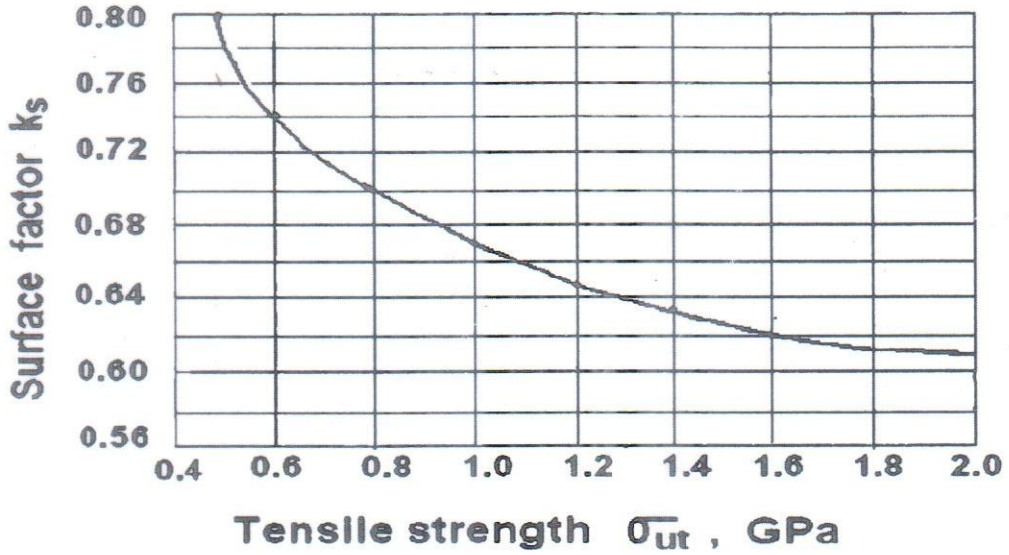


Fig.9.3 Surface factor K_s

Table 9.7 Reliability factor R

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

The induced dynamic contact stress is given by equation below,

$$\sigma_H = C_p \sqrt{\frac{F_t}{b d_1 I} K_V K_o K_m} \qquad (9.9)$$

Table 9.11 Elastic coefficient Cp for spur gears in $\sqrt{MPa}$

Pinion Material(μ=0.3 in all cases)	Gear material			
	Steel	Cast iron	Al Bronze	Tin Bronze
Steel, E=207Gpa	191	166	162	158
Cast iron, E=131Gpa	166	149	149	145
Al Bronze, E=121Gpa	162	149	145	141
Tin Bronze, E=110Gpa	158	145	141	137

$$I = \frac{\sin\phi\cos\phi}{2}\,\frac{i}{i+1}$$

Table 9.15 Surafce fatigue strength σ_{sf} for metallic spur gears (10^7 cycle life 99% reliability and temperature <120 ^{0} C)

Material	σ_{sf}'(MPa)
Steel	2.8 (Bhn)-69MPa
Nodular iron	0.95 (2.8(Bhn)-69MPa)
Cast iron, grade 20	379
Cast iron, grade 30	482
Cast iron, grade 40	551
Tin Bronze, AGMA 2C (11% Sn)	207
Aluminium Bronze (ASTM 148 – 52) (Alloy 9C – H.T.)	448

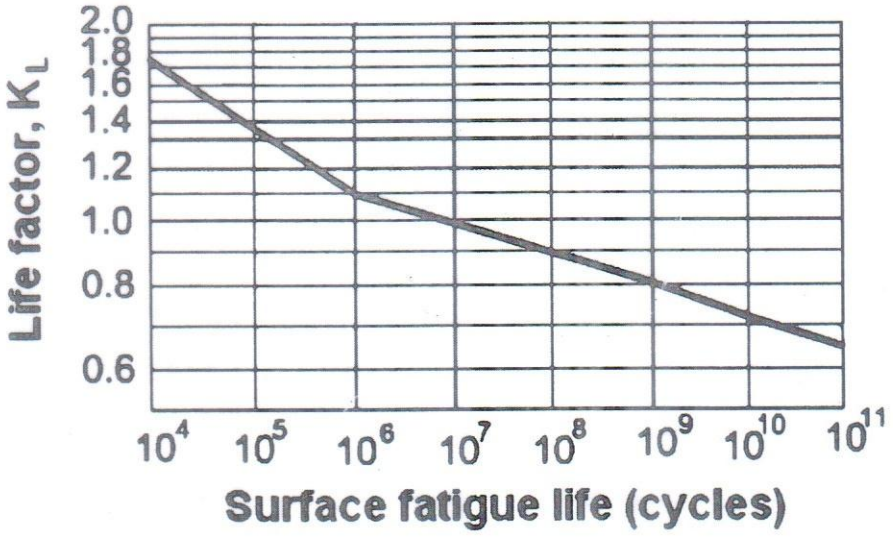


Fig. 9.5 Life factor K_l

Table 9.16 Reliability factor K_R

Reliability (%)	K_R
50	1.25
99	1.00
99.9	0.80

HELICAL GEAR

Transverse pressure angle

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

$$\varphi = \tan^{-1}\left(\frac{\tan \varphi_n}{\cos \psi}\right)$$

Bending stress on the pinion:

$$\sigma_{b1} = \frac{F_t}{b\, m_n\, J} K_v\, K_o\, (0.93 K_m)$$

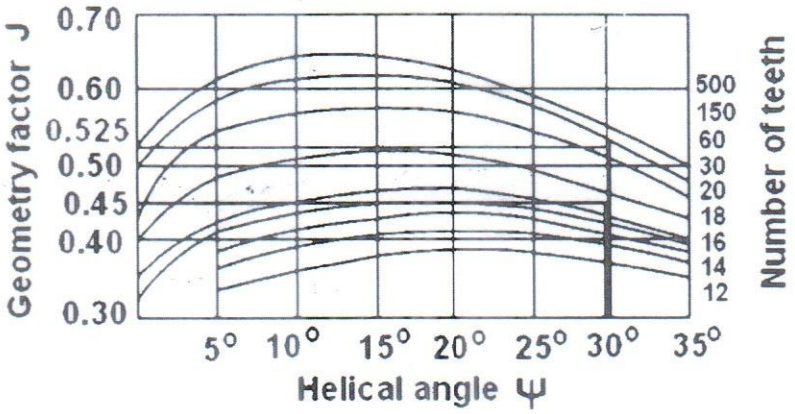


Fig.12.6 Geometry factor J for helical gear with $\varphi_n = 20^\circ$ and mating with 75 tooth gear

Table 12.4 Guidance on the necessary safety factor

Factor of safety against	Long life gearing	Finite life gearing
Tooth breakage $S_B \geqq$.	1,8 ··· 4	1,5 ··· 2
Pitting S_G	1,3 ··· 2,5	0,4 ··· 1
Scoring S_F	3 ··· 5	3 ··· 5

Contact stress on helical gears is given by:

$$\sigma_H = C_p \sqrt{\frac{F_t}{bdI}\left(\frac{\cos\psi}{0.95CR}\right) K_v K_o (0.93K_m)}$$

Contact ratio is given by:

$$CR_t = \left(\frac{\sqrt{(r_1+a)^2 - r_{b1}^{\ 2}} + \sqrt{(r_2+a)^2 - r_{b2}^{\ 2}} - (r_1+r_2)\sin\varphi}{\pi m \cos\varphi} \right)$$

Surface fatigue strength of pinion is:

$\sigma_{sf} = \sigma_{sf}' K_L K_H K_R K_T$

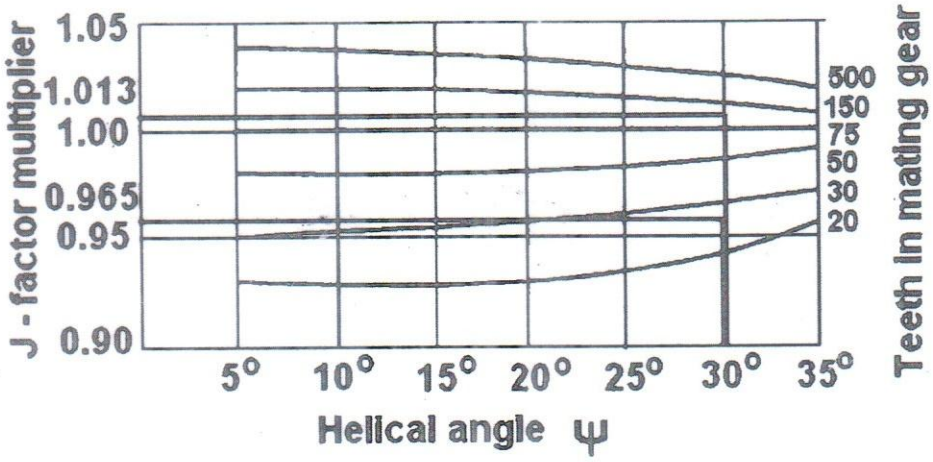


Fig.12.7 J- factor multiplier when the mating gear has tooth other than 75

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

k_m = Factor for miscellaneous effects. For idler gears subjected to two way bending, = 1. For other gears subjected to one way bending, the value is taken from the Fig.12.9. Use k_m = 1.33 for σ_{ut} less than 1.4 GPa.

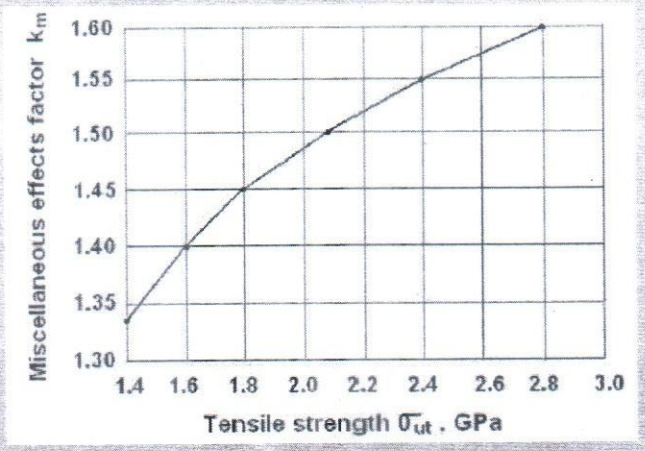


Fig.12.9 Miscellaneous effects factor, k_m

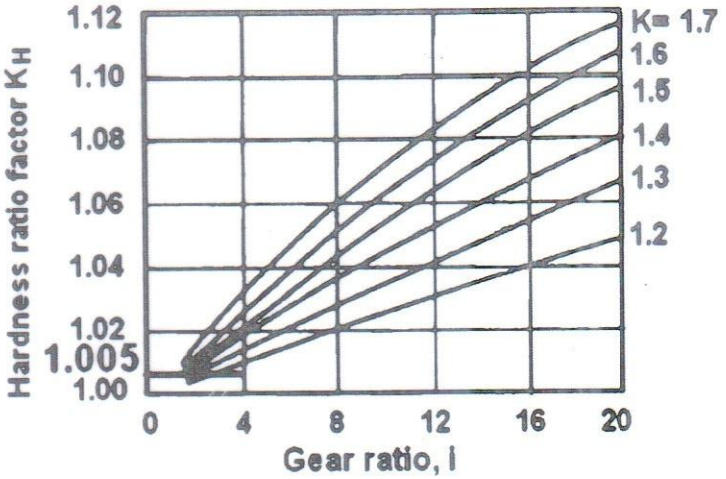


Fig. 12. 11 Hardness ratio factor, K_H
K = Brinell hardness ratio of pinion and gear, K_H = 1.0 for values of K below 1.2

BEVEL GEAR

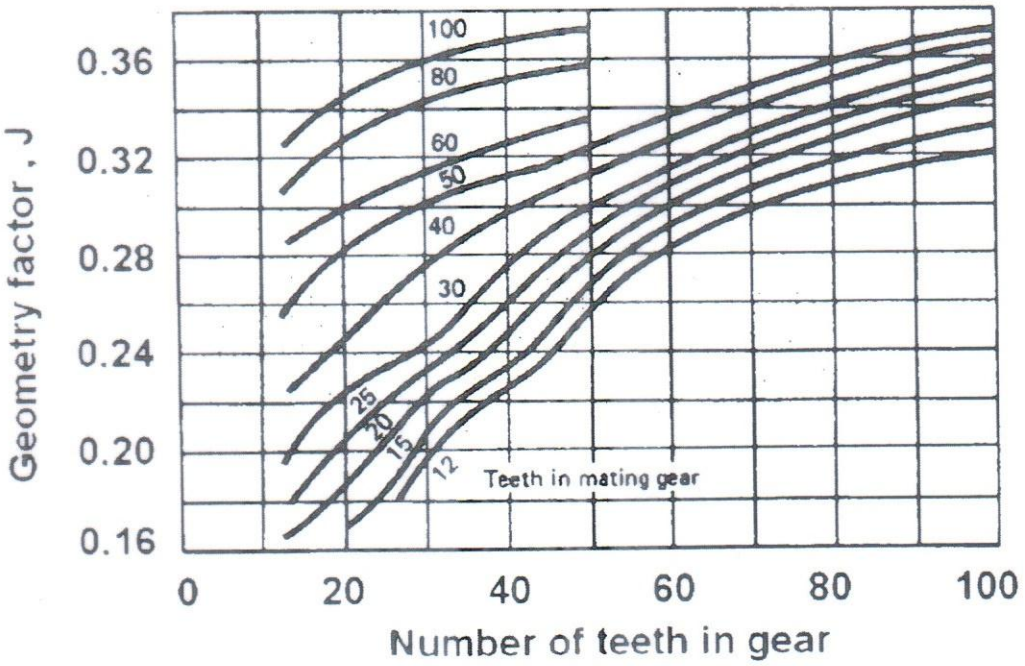


Fig. 14.10 Number of teeth in gear for which geometry factor J is desired, pressure angle 20° and shaft angle 90°

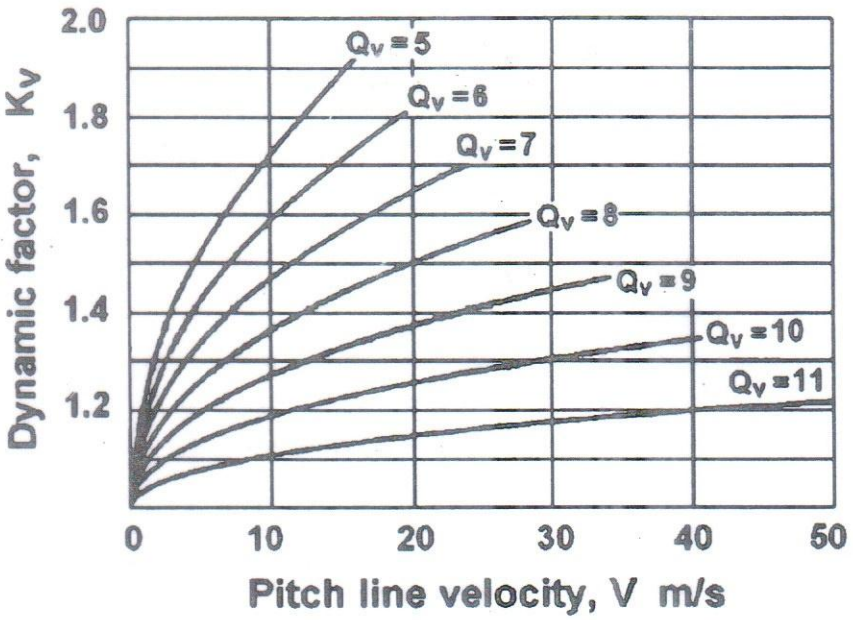
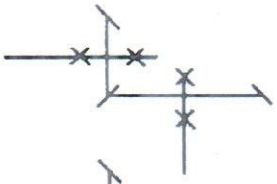
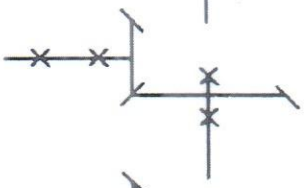
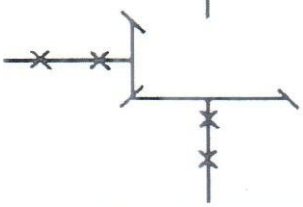


Fig. 14.11 Dynamic load factor, K_v

Table 14.5 BEVEL GEARS – MOUNTING FACTOR K_m

Mounting Type		Mounting Rigidity Maximum to Questionable
Both gears are straddle-mounted		1.0 to 1.25
One gear straddle-mounted; the other overhung		1.1 to 1.4
Both gear overhung		1.25 to 1.5

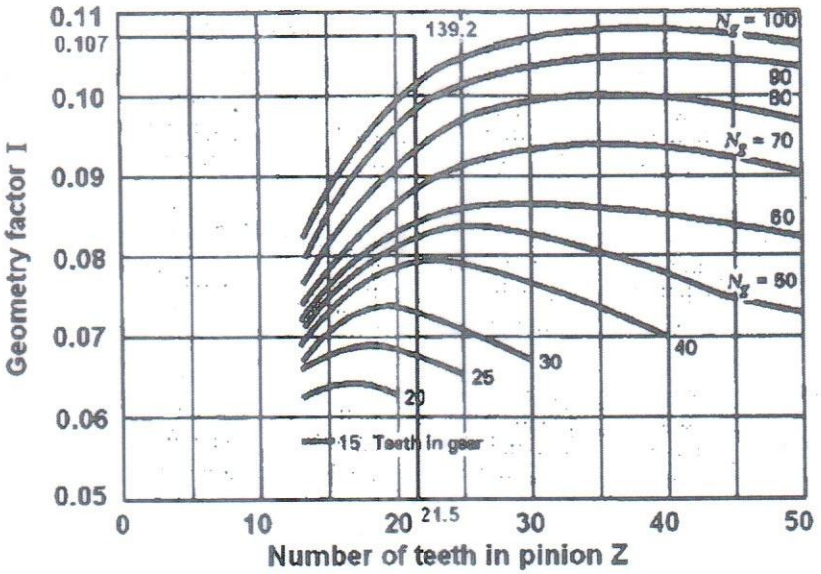


Fig. 14.12 Geometry factor I for straight bevel gear pressure angle 20° and shaft angle 90°

B.Sc Engg.(M)/8th Sem, B.ScTE/2Yr/3rd Sem./1Yr/1st Sem. 02 March, 2020 (Afternoon)

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

Mid Semester Examination
Course No.: MCE 4705/MCE 4791
Course Title: Applied Thermodynamics

Winter Semester: A.Y. 2019-2020
Time: 1 hour and 30 minutes
Full Marks: 75

There are 4 (Four) Questions. Question 1 is compulsory. Answer any 2 (Two) Questions from Questions 2-4.

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

1. A gas-turbine power plant operates on the regenerative Brayton cycle between the pressure limits of 100 and 700 kPa. Air enters the compressor at 30°C at a rate of 12.6 kg/s and leaves at 260°C. It is then heated in a regenerator to 400°C by the hot combustion gases leaving the turbine. A diesel fuel with a heating value of 42,000 kJ/kg is burned in the combustion chamber with a combustion efficiency of 97 percent. The combustion gases leave the combustion chamber at 871°C and enter the turbine whose isentropic efficiency is 85 percent. Treating combustion gases as air and using constant specific heats at 500°C, determine (*i*) the isentropic efficiency of the compressor, (*ii*) the effectiveness of the regenerator, (*iii*) the air–fuel ratio in the combustion chamber, (*iv*) the net power output and the back work ratio, (*v*) the thermal efficiency, and (vi) the second-law efficiency of the plant. Also determine (*vii*) the second-law efficiencies of the compressor, the turbine, and the regenerator, and (*viii*) the rate of the energy flow with the combustion gases at the regenerator exit. Draw appropriate schematic and T-s diagrams. [35]

2. a) Which properties of a system have been defined as consequences of the thermodynamic laws? Upon stating those laws, discuss briefly. [09]
   b) With an example, reason why *1st law efficiency is not a realistic measure of performance but 2nd law efficiency is*. [05]
   c) Draw the P-v and T-s diagram for Stirling and Ericsson cycles. [06]

3. a) Develop the expression for *Stream exergy change* (on a unit mass basis) during a process. [12]
   b) Show that "*The entropy of an isolated system during a process always increases or, in the limiting case of a reversible process, remains constant.*" [08]

4. a) Air enters a nozzle steadily at 280 kPa and 77°C with a velocity of 50 m/s and exits at 85 kPa and 320 m/s. The heat losses from the nozzle to the surrounding medium at 20°C are estimated to be 3.2 kJ/kg. Determine (*a*) the exit temperature and (*b*) the total entropy change for this process. [10]
   b) A piston–cylinder device initially contains 2 L of air at 100 kPa and 25°C. Air is now compressed to a final state of 600 kPa and 150°C. The useful work input is 1.2 kJ. Assuming the surroundings are at 100 kPa and 25°C, determine (i) the exergy of the air at the initial and the final states, (ii) the minimum work that must be supplied to accomplish this compression process, and (iii) the second-law efficiency of this process. [10]

TABLE A–1

Molar mass, gas constant, and critical–point properties

Substance	Formula	Molar mass, M kg/kmol	Gas constant, R kJ/kg·K*	*Critical-point properties* Temperature, K	Pressure, MPa	Volume, m^3/kmol
Air	—	28.97	0.2870	132.5	3.77	0.0883
Ammonia	NH_3	17.03	0.4882	405.5	11.28	0.0724
Argon	Ar	39.948	0.2081	151	4.86	0.0749
Benzene	C_6H_6	78.115	0.1064	562	4.92	0.2603
Bromine	Br_2	159.808	0.0520	584	10.34	0.1355
n–Butane	C_4H_{10}	58.124	0.1430	425.2	3.80	0.2547
Carbon dioxide	CO_2	44.01	0.1889	304.2	7.39	0.0943
Carbon monoxide	CO	28.011	0.2968	133	3.50	0.0930
Carbon tetrachloride	CCl_4	153.82	0.05405	556.4	4.56	0.2759
Chlorine	Cl_2	70.906	0.1173	417	7.71	0.1242
Chloroform	$CHCl_3$	119.38	0.06964	536.6	5.47	0.2403
Dichlorodifluoromethane (R–12)	CCl_2F_2	120.91	0.06876	384.7	4.01	0.2179
Dichlorofluoromethane (R–21)	$CHCl_2F$	102.92	0.08078	451.7	5.17	0.1973
Ethane	C_2H_6	30.070	0.2765	305.5	4.48	0.1480
Ethyl alcohol	C_2H_5OH	46.07	0.1805	516	6.38	0.1673
Ethylene	C_2H_4	28.054	0.2964	282.4	5.12	0.1242
Helium	He	4.003	2.0769	5.3	0.23	0.0578
n–Hexane	C_6H_{14}	86.179	0.09647	507.9	3.03	0.3677
Hydrogen (normal)	H_2	2.016	4.1240	33.3	1.30	0.0649
Krypton	Kr	83.80	0.09921	209.4	5.50	0.0924
Methane	CH_4	16.043	0.5182	191.1	4.64	0.0993
Metnyl alcohol	CH_3OH	32.042	0.2595	513.2	7.95	0.1180
Methyl chloride	CH_3Cl	50.488	0.1647	416.3	6.68	0.1430
Neon	Ne	20.183	0.4119	44.5	2.73	0.0417
Nitrogen	N_2	28.013	0.2968	126.2	3.39	0.0899
Nitrous oxide	N_2O	44.013	0.1889	309.7	7.27	0.0961
Oxygen	O_2	31.999	0.2598	154.8	5.08	0.0780
Propane	C_3H_8	44.097	0.1885	370	4.26	0.1998
Propylene	C_3H_6	42.081	0.1976	365	4.62	0.1810
Sulfur dioxide	SO_2	64.063	0.1298	430.7	7.88	0.1217
Tetrafluoroethane (R–134a)	CF_3CH_2F	102.03	0.08149	374.2	4.059	0.1993
Trichlorofluoromethane (R–11)	CCl_3F	137.37	0.06052	471.2	4.38	0.2478
Water	H_2O	18.015	0.4615	647.1	22.06	0.0560
Xenon	Xe	131.30	0.06332	289.8	5.88	0.1186

*The unit kJ/kg·K is equivalent to kPa·m^3/kg·K. The gas constant is calculated from $R = R_u/M$, where R_u = 8.31447 kJ/kmol·K and M is the molar mass.

Source of Data: K. A. Kobe and R. E. Lynn, Jr., *Chemical Review* 52 (1953), pp. 117–236; and ASHRAE, *Handbook of Fundamentals* (Atlanta, GA: American Society of Heating, Refrigerating and Air–Conditioning Engineers, Inc., 1993), pp. 16.4 and 36.1.

TABLE A–2

Ideal–gas specific heats of various common gases (*Continued*)

(*b*) At various temperatures

Temperature, K	c_p kJ/kg·K	c_v kJ/kg·K	k	c_p kJ/kg·K	c_v kJ/kg·K	k	c_p kJ/kg·K	c_v kJ/kg·K	k
	Air			*Carbon dioxide, CO_2*			*Carbon monoxide, CO*		
250	1.003	0.716	1.401	0.791	0.602	1.314	1.039	0.743	1.400
300	1.005	0.718	1.400	0.846	0.657	1.288	1.040	0.744	1.399
350	1.008	0.721	1.398	0.895	0.706	1.268	1.043	0.746	1.398
400	1.013	0.726	1.395	0.939	0.750	1.252	1.047	0.751	1.395
450	1.020	0.733	1.391	0.978	0.790	1.239	1.054	0.757	1.392
500	1.029	0.742	1.387	1.014	0.825	1.229	1.063	0.767	1.387
550	1.040	0.753	1.381	1.046	0.857	1.220	1.075	0.778	1.382
600	1.051	0.764	1.376	1.075	0.886	1.213	1.087	0.790	1.376
650	1.063	0.776	1.370	1.102	0.913	1.207	1.100	0.803	1.370
700	1.075	0.788	1.364	1.126	0.937	1.202	1.113	0.816	1.364
750	1.087	0.800	1.359	1.148	0.959	1.197	1.126	0.829	1.358
800	1.099	0.812	1.354	1.169	0.980	1.193	1.139	0.842	1.353
900	1.121	0.834	1.344	1.204	1.015	1.186	1.163	0.866	1.343
1000	1.142	0.855	1.336	1.234	1.045	1.181	1.185	0.888	1.335
	Hydrogen, H_2			*Nitrogen, N_2*			*Oxygen, O_2*		
250	14.051	9.927	1.416	1.039	0.742	1.400	0.913	0.653	1.398
300	14.307	10.183	1.405	1.039	0.743	1.400	0.918	0.658	1.395
350	14.427	10.302	1.400	1.041	0.744	1.399	0.928	0.668	1.389
400	14.476	10.352	1.398	1.044	0.747	1.397	0.941	0.681	1.382
450	14.501	10.377	1.398	1.049	0.752	1.395	0.956	0.696	1.373
500	14.513	10.389	1.397	1.056	0.759	1.391	0.972	0.712	1.365
550	14.530	10.405	1.396	1.065	0.768	1.387	0.988	0.728	1.358
600	14.546	10.422	1.396	1.075	0.778	1.382	1.003	0.743	1.350
650	14.571	10.447	1.395	1.086	0.789	1.376	1.017	0.758	1.343
700	14.604	10.480	1.394	1.098	0.801	1.371	1.031	0.771	1.337
750	14.645	10.521	1.392	1.110	0.813	1.365	1.043	0.783	1.332
800	14.695	10.570	1.390	1.121	0.825	1.360	1.054	0.794	1.327
900	14.822	10.698	1.385	1.145	0.849	1.349	1.074	0.814	1.319
1000	14.983	10.859	1.380	1.167	0.870	1.341	1.090	0.830	1.313

Source of Data: Kenneth Wark, *Thermodynamics*, 4th ed. (New York: McGraw–Hill, 1983), p. 783, Table A–4M. Originally published in *Tables of Thermal Properties of Gases*, NBS Circular 564, 1955.

TABLE A–17

Ideal-gas properties of air

T K	h kJ/kg	P_r	u kJ/kg	v_r	s° kJ/kg·K	T K	h kJ/kg	P_r	u kJ/kg	v_r	s° kJ/kg·K
200	199.97	0.3363	142.56	1707.0	1.29559	580	586.04	14.38	419.55	115.7	2.37348
210	209.97	0.3987	149.69	1512.0	1.34444	590	596.52	15.31	427.15	110.6	2.39140
220	219.97	0.4690	156.82	1346.0	1.39105	600	607.02	16.28	434.78	105.8	2.40902
230	230.02	0.5477	164.00	1205.0	1.43557	610	617.53	17.30	442.42	101.2	2.42644
240	240.02	0.6355	171.13	1084.0	1.47824	620	628.07	18.36	450.09	96.92	2.44356
250	250.05	0.7329	178.28	979.0	1.51917	630	638.63	19.84	457.78	92.84	2.46048
260	260.09	0.8405	185.45	887.8	1.55848	640	649.22	20.64	465.50	88.99	2.47716
270	270.11	0.9590	192.60	808.0	1.59634	650	659.84	21.86	473.25	85.34	2.49364
280	280.13	1.0889	199.75	738.0	1.63279	660	670.47	23.13	481.01	81.89	2.50985
285	285.14	1.1584	203.33	706.1	1.65055	670	681.14	24.46	488.81	78.61	2.52589
290	290.16	1.2311	206.91	676.1	1.66802	680	691.82	25.85	496.62	75.50	2.54175
295	295.17	1.3068	210.49	647.9	1.68515	690	702.52	27.29	504.45	72.56	2.55731
298	298.18	1.3543	212.64	631.9	1.69528	700	713.27	28.80	512.33	69.76	2.57277
300	300.19	1.3860	214.07	621.2	1.70203	710	724.04	30.38	520.23	67.07	2.58810
305	305.22	1.4686	217.67	596.0	1.71865	720	734.82	32.02	528.14	64.53	2.60319
310	310.24	1.5546	221.25	572.3	1.73498	730	745.62	33.72	536.07	62.13	2.61803
315	315.27	1.6442	224.85	549.8	1.75106	740	756.44	35.50	544.02	59.82	2.63280
320	320.29	1.7375	228.42	528.6	1.76690	750	767.29	37.35	551.99	57.63	2.64737
325	325.31	1.8345	232.02	508.4	1.78249	760	778.18	39.27	560.01	55.54	2.66176
330	330.34	1.9352	235.61	489.4	1.79783	780	800.03	43.35	576.12	51.64	2.69013
340	340.42	2.149	242.82	454.1	1.82790	800	821.95	47.75	592.30	48.08	2.71787
350	350.49	2.379	250.02	422.2	1.85708	820	843.98	52.59	608.59	44.84	2.74504
360	360.58	2.626	257.24	393.4	1.88543	840	866.08	57.60	624.95	41.85	2.77170
370	370.67	2.892	264.46	367.2	1.91313	860	888.27	63.09	641.40	39.12	2.79783
380	380.77	3.176	271.69	343.4	1.94001	880	910.56	68.98	657.95	36.61	2.82344
390	390.88	3.481	278.93	321.5	1.96633	900	932.93	75.29	674.58	34.31	2.84856
400	400.98	3.806	286.16	301.6	1.99194	920	955.38	82.05	691.28	32.18	2.87324
410	411.12	4.153	293.43	283.3	2.01699	940	977.92	89.28	708.08	30.22	2.89748
420	421.26	4.522	300.69	266.6	2.04142	960	1000.55	97.00	725.02	28.40	2.92128
430	431.43	4.915	307.99	251.1	2.06533	980	1023.25	105.2	741.98	26.73	2.94468
440	441.61	5.332	315.30	236.8	2.08870	1000	1046.04	114.0	758.94	25.17	2.96770
450	451.80	5.775	322.62	223.6	2.11161	1020	1068.89	123.4	776.10	23.72	2.99034
460	462.02	6.245	329.97	211.4	2.13407	1040	1091.85	133.3	793.36	23.29	3.01260
470	472.24	6.742	337.32	200.1	2.15604	1060	1114.86	143.9	810.62	21.14	3.03449
480	482.49	7.268	344.70	189.5	2.17760	1080	1137.89	155.2	827.88	19.98	3.05608
490	492.74	7.824	352.08	179.7	2.19876	1100	1161.07	167.1	845.33	18.896	3.07732
500	503.02	8.411	359.49	170.6	2.21952	1120	1184.28	179.7	862.79	17.886	3.09825
510	513.32	9.031	366.92	162.1	2.23993	1140	1207.57	193.1	880.35	16.946	3.11883
520	523.63	9.684	374.36	154.1	2.25997	1160	1230.92	207.2	897.91	16.064	3.13916
530	533.98	10.37	381.84	146.7	2.27967	1180	1254.34	222.2	915.57	15.241	3.15916
540	544.35	11.10	389.34	139.7	2.29906	1200	1277.79	238.0	933.33	14.470	3.17888
550	555.74	11.86	396.86	133.1	2.31809	1220	1301.31	254.7	951.09	13.747	3.19834
560	565.17	12.66	404.42	127.0	2.33685	1240	1324.93	272.3	968.95	13.069	3.21751
570	575.59	13.50	411.97	121.2	2.35531						

M Sc. Engg. (MCE)/ M Sc. TE(2 Yr) 27 February, 2020 (Afternoon)

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

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

Winter Semester: A.Y. 2019-2020
Time : 1½ hours
Full Marks : 75

OPEN BOOK

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

---

1. a) i. Consider steady, laminar, two-dimensional flow over an isothermal plate. Does the thickness of the velocity boundary layer increase or decrease with (a) distance from the leading edge, (b) free-stream velocity, and (c) kinematic viscosity? [2.5]

ii. Consider a hot baked potato. Will the potato cool faster or slower when we blow the warm air coming from our lungs on it instead of letting it cool naturally in the cooler air in the room? Explain. [2.5]

iii. When is heat transfer through a fluid conduction and when is it convection? For what case is the rate of heat transfer higher? How does the convection heat transfer coefficient differ from the thermal conductivity of a fluid? [2.5]

iv. Consider steady, laminar, two-dimensional, incompressible flow with constant properties and a Prandtl number of unity. For a given geometry, is it correct to say that both the average friction and heat transfer coefficients depend on the Reynolds number only? [2.5]

b) The flow of oil in a journal bearing shown in **Fig. 1** can be approximated as parallel flow between two large plates with one plate moving and the other stationary. Such flows are known as Couette flow. Consider two large isothermal plates separated by 2-mm-thick oil film. The upper plates move at a constant velocity of 12 m/s, while the lower plate is stationary. Both plates are maintained at 20°C. (a) Obtain relations for the velocity and temperature distributions in the oil. (b) Determine the maximum temperature in the oil and the heat flux from the oil to each plate. [15]

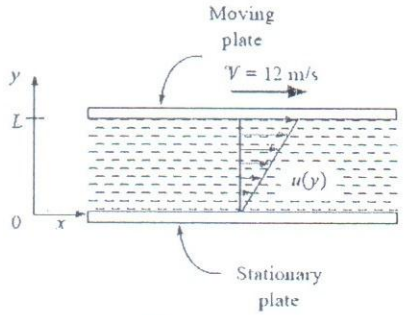


Figure:01

2. a) i. What is external forced convection? How does it differ from internal forced convection? Can a heat transfer system involve both internal and external convection at the same time? Give an example. [2.5]

ii. What is the physical significance of the Prandtl number? Does the value of the Prandtl number depend on the type of flow or the flow geometry? Does the Prandtl number of air change with pressure? Does it change with temperature? [2.5]

iii. Consider steady, laminar, two-dimensional, incompressible flow with constant properties and a Prandtl number of unity. For a given geometry, is it correct to say that both the average friction and heat transfer coefficients depend on the Reynolds number only? [2.5]

iv. Will a thermal boundary layer develop in flow over a surface even if both the fluid and the surface are at the same temperature? [2.5]

b) During air cooling of potatoes, the heat transfer coefficient for combined convection, radiation, and evaporation is determined experimentally to be shown in **Table 01**.
Consider a 10-cm-diameter potato initially at 20°C with a thermal conductivity of 0.49 W/m.°C. Potatoes are cooled by refrigerated air at 5°C at a velocity of 1 m/s. Determine the initial rate of heat transfer from a potato, and the initial value of the temperature gradient in the potato at the surface. [15]

Air Velocity, m/s	Heat Transfer Coefficient, W/m² · °C
0.66	14.0
1.00	19.1
1.36	20.2
1.73	24.4

Table: 01

a) i. Consider the flow of mercury (a liquid metal) in a tube. How will the hydrodynamic and thermal entry lengths compare if the flow is laminar? How would they compare if the flow were turbulent? [2.5]

ii. Consider fully developed flow in a circular pipe with negligible entrance effects. If the length of the pipe is doubled, the pressure drop will (a) double, (b) more than double, (c) less than double, (d) reduce by half, or (e) remain constant. [2.5]

iii. Consider fluid flow in a tube whose surface temperature remains constant. What is the appropriate temperature difference for use in Newton's law of cooling with an average heat transfer coefficient? [2.5]

iv. What does the logarithmic mean temperature difference represent for flow in a tube whose surface temperature is constant? Why do we use the logarithmic mean temperature instead of the arithmetic mean temperature? [2.5]

b) Consider the flow of oil as shown in **Fig. 2** at 20°C in a 30-cm-diameter pipeline at an average velocity of 2 m/s. A 200-m-long section of the pipeline passes through icy waters of a lake at 0°C. Measurements indicate that the surface temperature of the pipe is very nearly 0°C. Disregarding the thermal resistance of the pipe material, determine (*a*) the temperature of the oil when the pipe leaves the lake, (*b*) the rate of heat transfer from the oil, and (*c*) the pumping power required to overcome the pressure losses and to maintain the flow of the oil in the pipe. [15]

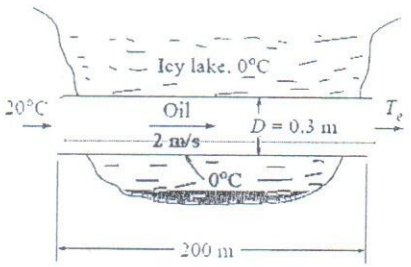


Figure: 02

4. Water flows with a mean velocity of 2 m/s inside a circular pipe of inside diameter of 5 cm. The pipe is of commercial steel and its wall is maintained at a uniform temperature of 100°C by condensing steam on its outer surface. At a location where the fluid is hydrodynamically and thermally developed, the bulk mean temperature of water is 60°C. Properties at bulk mean temperature for water are given as follows: [25]

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

Calculate the heat transfer coefficient h for a smooth pipe by using the following correlations:

i. The Notter and Sleicher equation.
ii. The Petukhov equation.
iii. The Sieder and Tate equation.
iv. The Dittus and Boelter equation.