

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

Mid Semester Examination

Course No. Phy 4113

Course Title: Physics I

Winter Semester 2015-2016

Time: 1½ HRS.

Full Marks: 75

There are **FOUR** Questions. Answer any **THREE** Questions.

Marks in the Margin indicate full marks.

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

1. (a) Explain the statement "Charge is quantized". What is a dipole? Derive the expressions for the torque, $\tau = \mathbf{p} \times \mathbf{E}$, and the potential energy, $U = -\mathbf{p} \cdot \mathbf{E}$, of an electric dipole in an electric field, where the symbols have their usual meanings. (18)
(b) Two point charges q_1 and q_2 are 10 m apart and their combined charge is 2.0×10^{-7} C. Calculate the magnitudes of the two charges if (i) one repels the other with a force of 0.07 N, and (ii) one attracts the other with a force of 0.52 N? (7)
2. (a) What is a capacitor? Define capacitance of a capacitor. Show that the induced surface charge q' is always less in magnitude than the free charge q when a parallel plate capacitor is filled with a dielectric of dielectric constant κ and hence obtain the Gauss's law for this case. (18)
(b) A parallel plate capacitor is charged with 10.0 nC and has a 120 V potential difference between its terminals. Compute its capacitance and the energy stored in it. (Assume no dielectric between the plates and $\epsilon_0 = 8.9 \times 10^{-12}$ C/N-m²). (7)
3. (a) Derive the expressions for the growth and decay of charges when a capacitor is charged and discharged respectively through a resistor. What is capacitive time constant? (18)
(b) A 150 μF capacitor is connected through resistor of 500 Ω to a battery of 40 V. What are the time constant and the final charge q_0 on a capacitor plate? (7)
4. (a) Define magnetic flux and magnetic field induction, B . What is Lorentz force? Derive an expression for the magnetic force on a wire of length, l , carrying a current, i , placed at right angles to a magnetic field induction, B . (18)
(b) Find the magnitude of the magnetic field B at a distance of 10 cm due to a long straight conductor carrying a current of 150 A. (Permeability of free space $= 4\pi \times 10^{-7}$ H/m) (7)

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MID SEMESTER EXAMINATION

Course No. Chem 4115

Course Title: Chemistry

WINTER SEMESTER: 2015-2016

TIME : 1 ½ HRS

Full Marks : 75

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

- Q1. a) State Raoult's law of lowering of vapour pressure and deduce an expression to [10]
establish relationship between the molecular weight of a solute and lowering of pressure.
- b) Explain why the boiling point of a liquid rises when a non volatile solute is dissolved in it and the dissolution of gases in liquid is exothermic. [6]
- c) The vapour pressure of ether at 25°C is 445mm of Hg. When 6.5gm solute is dissolved in 50gm ether, the vapour pressure of the solution is 410mm of Hg. What is the MW of the Solute when the MW of ether is 74gm/mol? [9]
- Q 2. Write short notes: [5x5=25]
- a) Critical Solution Temperature (CST)
 - b) Bohr's Atom Model
 - c) Order and Molecularity
 - d) Heat of Formation and Heat of Solution
 - e) AUFBAU and Heisenberg Uncertainty Principle
- Q 3.a) What is Thermochemical Equation? Discuss the factors which govern the equation. [6]
- b) Define Heat of Combustion and Heat of Neutralization. Describe the method to determine the Heat of Combustion in the laboratory. Why the value of heat of combustion is very important? Explain. [4+6+2]
- c) The heat of reaction for the reaction $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$ is -21.976Kcal at 27°C. What will be the heat of reaction at 323K? The molar heat capacities at constant pressure and at 27°C for N_2 , H_2 and NH_3 are 6.8, 6.77 and 8.86 cal.mol⁻¹.deg⁻¹ respectively. [7]
- Q 4.a) State and explain LeChatelier principle. What is the effect of pressure and catalyst on equilibrium constant (K)? Illustrate with examples. [3+6]
- b) Derive the relationship between K_p and K_c for homogeneous gaseous system. [8]
- c) 35% N_2O_4 is dissociated at 100°C. If the total pressure is 2atm., find out the value of K_p and K_c . [8]

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Mid Semester Examination

Course No.: Math 4111

Course Title: Mathematics I

Winter Semester: A.Y. 2015-2016

Time: 1 Hour 30 Minutes

Full Marks: 100

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 anything on the question paper.

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1. (a) Under which condition the lines whose direction cosines are given by the equations $l + m + n = 0$ and $al^2 + bm^2 + cn^2 = 0$ are perpendicular and parallel. 18
- (b) Find the angle between the lines whose direction cosines are given by the equations $l + m + n = 0$ and $l^2 + m^2 - n^2 = 0$. $15\frac{1}{3}$
2. (a) Find the equation of the plane through the points $(1, -2, 2)$, $(-3, 1, -2)$ and perpendicular to the plane $2x + y - z + 6 = 0$. Also find the angle between the planes $2x - y + z = 6$ and $x + y + 2z = 7$. 18
- (b) A variable plane makes intercepts on the coordinate axes, the sum of whose square is constant. Find the locus of the foot of the perpendicular from the origin to the plane. $15\frac{1}{3}$
3. (a) Find the length and the equation of the line of shortest distance between the lines $\frac{x-3}{3} = \frac{y-8}{-1} = \frac{z-3}{1}$ and $\frac{x+3}{-3} = \frac{y+7}{2} = \frac{z-6}{4}$. 18
- (b) Show that the lines $\frac{x+5}{3} = \frac{y+4}{1} = \frac{z-7}{-2}$ and $3x + 2y + z - 2 = 0 = x - 3y + 2z - 13$ are coplanar. Also find the equation of the plane in which they lie. $15\frac{1}{3}$
4. (a) A function $f(x)$ is defined by $f(x) = \begin{cases} x^3 + 1, & x < 1 \\ x + 1, & x \geq 1. \end{cases}$ 8
- Find $\lim_{x \rightarrow 1} f(x)$, if it exists.

(b) Given $f(x) = \begin{cases} x^2 - 3x, & x > 4 \\ 2x - 5, & x \leq 4. \end{cases}$

Discuss the continuity of $f(x)$ at $x = 4$ and the existence of $f'(x)$ at $x = 4$. Also, use a graphing utility to graph the function $f(x)$.

(c) Find the tangent line to the graph given by $x^2(x^2 + y^2) = y^2$ at the point $(\sqrt{2}/2, \sqrt{2}/2)$.

(d) Differentiate $f(x) = \ln \frac{x(x^2 + 1)^2}{\sqrt{2x^3 - 1}}$ with respect to x .

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DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

MID SEMESTER EXAMINATION

Course No: MCE-4103

Course Name: Engineering Mechanics

WINTER SEMESTER: 2015-2016

TIME : 1HR 30 MINS

FULL MARKS: 100

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

1. (a) Resolve F_2 into components along the u and v axes as shown in Fig. 1a and determine the magnitudes of F_1 and F_2 in u and v axes. (16)
- (b) Determine the stretch in each of the two springs required to hold the 20-kg crate in the equilibrium position as shown in Fig. 1b. Each spring has an unstretched length of 2 m and a stiffness of $k = 300$ N-m. (17)
2. (a) Two boys push on the gate as shown in Fig. 2a. If the boy at B exerts a force of $FB = 30$ lb, determine the magnitude of the force FA the boy at A must exert in order to prevent the gate from turning. Neglect the thickness of the gate. (16)
- (b) The winch as shown in Fig. 2b consists of a drum of radius 4 in., which is pin connected at its center C . At its outer rim is a ratchet gear having a mean radius of 6 in. The pawl AB serves as a two-force member (short link) and keeps the drum from rotating. If the suspended load is 500 lb, determine the horizontal and vertical components of reaction at the pin C . (17)
3. (a) Determine the forces acting in all the members of the truss as shown in Fig. 3a. (16)
- (b) Determine the maximum weight W the man can lift with constant velocity using the pulley system as shown in Fig. 3b, without and then with the pulley at A . The man has a weight of 200 lb and the coefficient of static friction between his feet and the ground is $\mu_s = 0.6$. (17)
4. (a) Locate the centroid of the area as shown in Fig. 4a. (16)
- (b) Determine the moment of inertia of the area as shown in Fig. 4b about the x axis. (17)

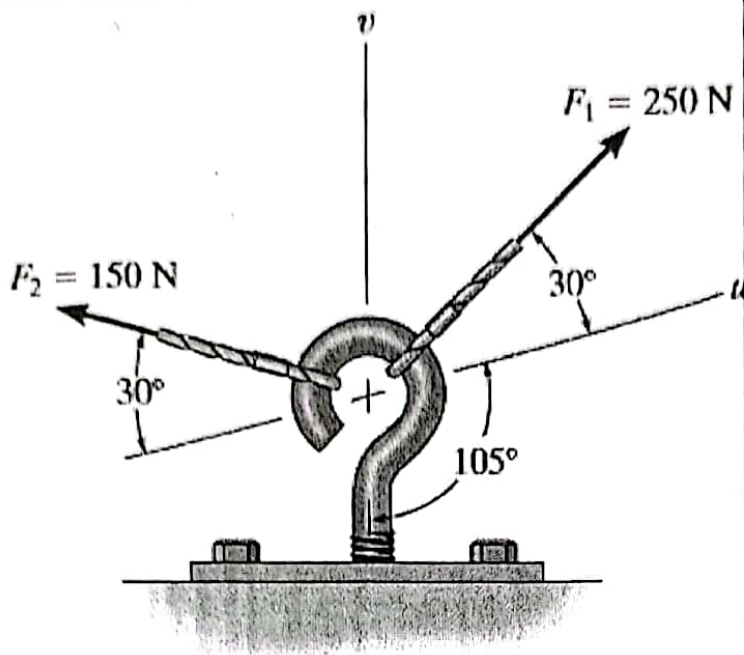


Figure-1a

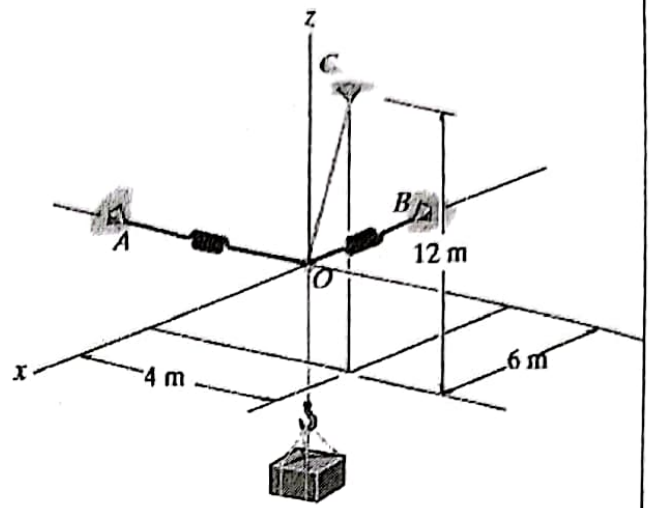


Figure-1b

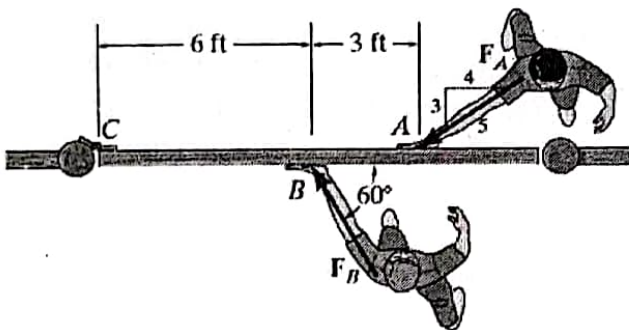


Figure-2a

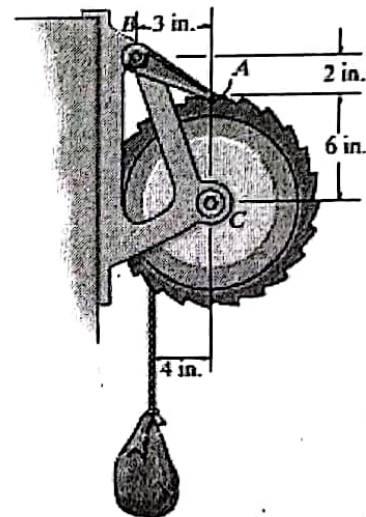


Figure-2b

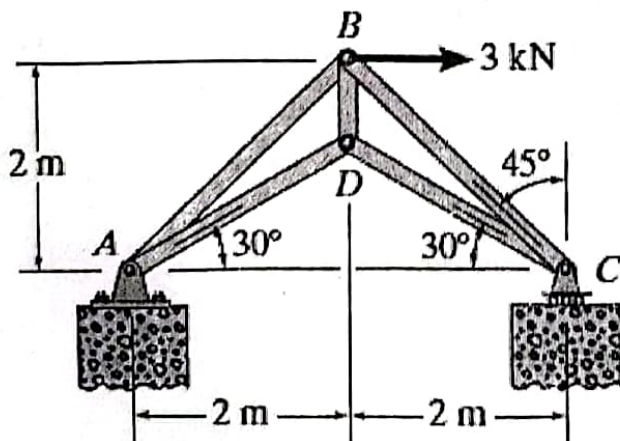


Figure-3a

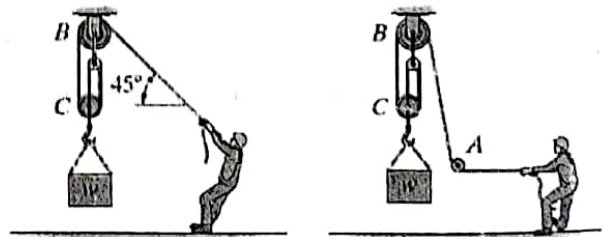


Figure-3b

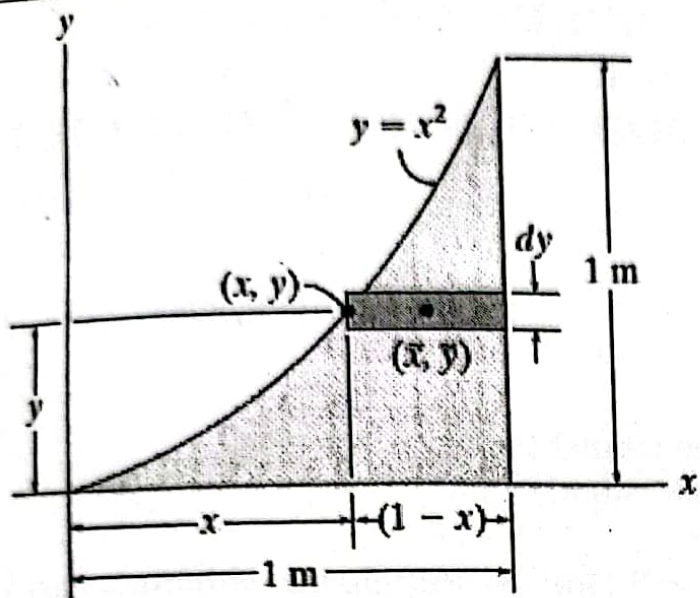


Figure-4a

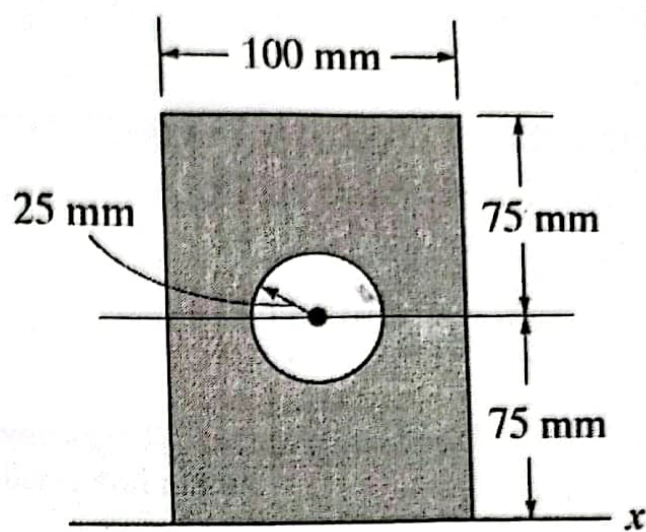


Figure-4b

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DEPARTMENT OF MECHANICAL AND CHEMICAL ENGINEERING

Mid Semester Examination

Course No.: MCE 4101

Course Title: Introduction to Mechanical Engineering

Winter Semester, A. Y. 2015-2016

Time: 1 Hour 30 Min(s)

Full Marks: 75

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

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

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| 1. a) | Differentiate between renewable and non-renewable source of energy. Briefly explain the tower concept of solar power generation. | 12 |
| b) | What are the types of wind mill? Explain the various types of wind mills with a neat sketch. | 13 |
| 2. a) | Explain briefly the different classifications of IC Engines. Compare the SI and CI engine in all aspects in a Tabular form. | 15 |
| b) | What is an indicator diagrams? How it is represented? Explain briefly IHP, BHP and FHP and mechanical efficiency. | 10 |
| 3. a) | What is Turbine? What are the differences in between Impulse turbine and reaction turbine? | 12 |
| b) | What is fluid machine? Explain with necessary diagram the cycle of operation of a positive displacement pump? | 08 |
| c) | What is compression ratio? How is it important? | 05 |
| 4. a) | Explain with neat sketches the constructional features and working principle of a Babcock & Wilcox boiler. | 13 |
| b) | List the different mountings and accessories used in Boiler. Explain the function with neat sketches of fusible plug, feed check valve used in boiler. | 12 |