BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2   B. Sc. Engineering Examinations 2017-2018

Sub: **CHEM 101** (Chemistry-I)

Full Marks: 210   Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1   (a) Scale formation in boiler pipe is nothing but the consequence of solubility of CO_2 gas in water in the presence of Ca^{2+} ions-Justify the statement.   **(8)**

(b) Illustrate the molecular view of the solution process and explain that the energy and entropy both are involved in the process of solution.   **(8)**

(c) The fizzing is a physical change that involves the release of gaseous bubbles and makes a hissing sound. Which one has the better fizzing; cold or warm carbonated drinks? Explain.   **(6)**

(d) Show that the freezing point depression is a colligative property. Decide the mass of ethylene glycol ($C_2H_6O_2$), the main component of antifreeze, must be added to 10L water to produce a solution for use in a car's radiator that freezes at -10.0°F? Assume the density of water is 1g/mL. [the freezing point depression constant is 0.51 °C.kg/mol.   **(7+6=13)**

2.   (a) Define the term 'boiling point of solution'. Elevation of boiling point is a consequence of vapor pressure lowering-Justify.   **(2+6=8)**

(b) Apply the concept of osmosis and draw a diagram of the water desalination system with the operational principle.   **(8)**

(c) At room temperature the water is liquid but CO_2 is gas. Explain with the help of phase diagram.   **(10)**

(d) Draw the phase diagram of sulfur and show (i) formation of metastable equilibrium without the existence of monoclinic sulfur (ii) four phase equilibrium is not possible in the sulfur system.   **(6+3=9)**

3.   (a) Show that for a first-order reaction the half-life is independent of the initial concentration but for a zero order reaction it is somehow dependent on the concentration of the reactants.   **(12)**

(b) For the following reaction, what will be your approach to determine the rate constants for the branches? If $k_1 > k_2$, draw the reaction profile.   **(10)**
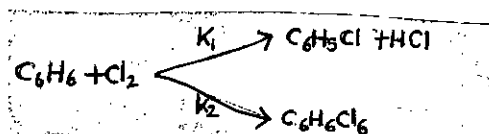
CHEM 101
<u>Contd... Q. No. 3</u>

(c) The higher order reactions are improbable-justify with your concept of collision theory of reaction rate. **(7)**

(d) For a reaction, the energy of activation is zero. What is the value of the rate constant at 300 K if $k = 1.6 \times 106$ s^{-1} at 280 K? **(6)**

4. (a) What is the scope of thermochemistry? Define the following terms **(8)**
(i) intensive property (ii) isolated system (iii) state function

(b) Derive an expression showing the temperature dependence of enthalpy of reaction. **(11)**

(c) Using the first law of thermodynamics proves that change in internal energy is associated with a constant volume process and change in enthalpy is associated with a constant pressure process. **(8)**

(d) Two pollutants that form in the auto exhaust are CO and NO. An environmental engineer must convert these pollutants to less harmful gases through the following: **(8)**

$$CO(g) + NO(g) \rightarrow CO_2(g) + \tfrac{1}{2}N_2(g)$$

Calculate the ∆H for the reaction from the following information.

Equation A: $CO(g) + \tfrac{1}{2}O_2(g) \rightarrow CO_2(g)$ $\Delta H = -283.0$ kJ

Equation B: $N_2(g) + O_2(g) \rightarrow 2NO(g)$ $\Delta H = 180.6$ kJ

## <u>SECTION - B</u>
There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) What is meant by quantization of energy? How does de Broglie's hypothesis account for the fact that the energies of the electron in a hydrogen atom are quantized? **(5+5)**

(b) If particles have wavelike motion, why don't we observe that motion in the microscopic world? **(5)**

(c) Why does the Bohr model of Hydrogen atom violate the uncertainty principle? The concept of electron density is better suited to describe the position of an electron in the quantum mechanical model of an atom- Justify. **(5+5)**

(d) (i) Calculate the energies needed to remove an electron from the n =1 state and the n = 5 state in the Li^{2+} ion. What is the wavelength (in nm) of the emitted photon in a transition from n = 5 to n = 1? [Rydberg's constant is 2.18×10^{-18} J for hydrogen].

(ii) Suppose the same transition as in part (i) took place in a hydrogen atom, would the wavelength of emission be longer than, shorter than or the same as your answer to part(i). **(6+4)**

6. (a) (i) For a given value of the principle quantum number, n, how do the energies of the s, p and d sub levels vary for (1) Hydrogen (2) Phosphorous.

(ii) Which of the following species has the most unpaired electrons? S$^+$, S, or S$^-$. Explain how you arrive at your answer. **(4+3)**

CHEM 101

Contd... Q. No. 6

(b) Sketch the outline of the periodic table and show group and period trends in the first acidity of oxides, metallic character and atomic size of the elements. **(10)**

(c) Using the Na (Z = 11) atom as an example, describe the effect of shielding on the 1st ionization energy. What types of elements have the highest ionization energies and the lowest ionization energies? **(4+2)**

(d) What is lattice energy and what role does it play in the stability of ionic compounds? Explain how the lattice energy of KCl can be determined using the Born-Haber cycle. On what law is this procedure based. **(4+7+1)**

7. (a) Why does hydrogen gas consist of H_2 molecules and not separate H atoms? **(6)**

(b) In AB_4E arrangement (A is the central atom and E represents lone pair), why does the lone pair occupy an equatorial position rather than axial position? Sketch the bond moments and resultant dipole moments for the following molecules: H_2O, PCl_5, NH_3, CF_4 **(4+4)**

(c) Find out the Hybridization, geometry and shape of the following ions/molecules by drawing Lewis structure: IF_4^-, IF_2^+, IF_5 and I_3^- **(3×4=12)**

(d) What effect of *2s-2p* mixing is observed in relative energy level of molecular orbitals (MOs) in homonuclear diatomic molecules of period 2 elements? Compare the Lewis and molecular orbital treatments of the oxygen molecule. **(4+5)**

8. (a) Methoxide ion, CH_3O^-, and amide ion, NH_2^- are very strong bases that are "leveled" by water, explain. What feature must a molecule or ion have in order to act as a Lewis base and as a Lewis acid? **(4+2)**

(b) The pH of a bicarbonate-carbonic acid buffer is 8.00. Calculate the ratio of the concentration of carbonic acid to that of the bicarbonate ion. Given that, **(6)**

$$H_2CO_3(aq) \rightleftharpoons HCO_3^-(aq) + H^+(aq) \quad K_{a_1} = 4.2 \times 10^{-7}$$

(c) The galvanic cell represented below consists of a hydrogen half-cell and a magnesium half-cell at standard conditions. The reading on the voltmeter is **2.36 V**. **(4×4=16)**
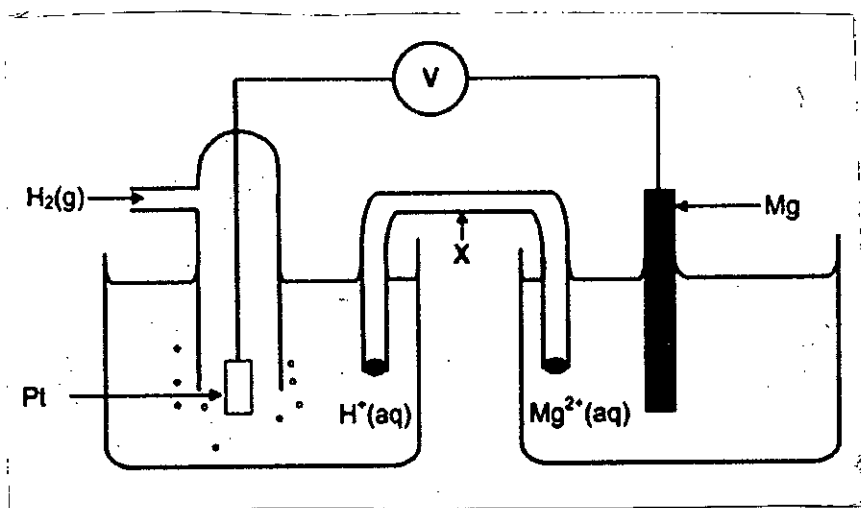
CHEM 101

(i) Label all the components of this cell. What are the conditions needed for the hydrogen half-cell to function at standard conditions?

(ii) Write down the cell notation/diagram for this cell. Give the balanced NET (overall) cell reaction that takes place in this cell.

(iii) Calculate the standard reduction potential of the magnesium half- cell.

(iv) Comment on the spontaneity of the cell reaction based on the standard free energy change. ($F= 96,484$ C mol^{-1})

(d) The concentration of K^+ ion in the interior and exterior of a nerve cell are 400 mM and 15 mM, respectively. Find the electrical potential across the membrane. [$K^+ + e^- = K$; $E° = -2.92V$]. Which direction the K^+ movement will be spontaneous? **(5+2)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2   B. Sc. Engineering Examinations 2017-2018

Sub: **PHY 165** (Electricity and Magnetism, Modern Physics and Mechanics)

Full Marks: 210   Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Distinguish between inertial and non-inertial frames of references. Give one
    example of each. Is earth an inertial frame? Give reasons.   **(8)**

    (b) Derive Lorentz transformation equations for space and time coordinates and show
    that these equations become the Galilean equations at very low speed.   **(22)**

    (c) Calculate the speed of a 2-MeV electron.   **(5)**

2. (a) What are Planck's quantum hypothesis and photoelectric effect?   **(5)**

    (b) (i) Discuss photoelectric effect by drawing a schematic diagram of the apparatus.   **(18+5=23)**

    (ii) Discuss how classical electromagnetic theory of light fails to explain the basic facts
    of photoelectricity.

    (c) A proton and a deuteron have the same kinetic energy. Find which has a longer
    wavelength.   **(7)**

3. (a) Show with arguments that proton can exist in the nucleus.   **(6)**

    (b) (i) What do you mean by mass defect and binding energy of a nucleus? Draw the
    curve of binding energy per nucleon versus mass number and explain it.   **(15+9)**

    (ii) Define mean life of a radioactive nuclide. Derive a relation between mean life time
    and disintegration constant.

    (c) Calculate the activity of 0.1 mg sample of ^{90}Sr at time t = 9s if the half life of ^{90}Sr
    is 28 years. (Avogadro's number = 6.023×10^{23} per gm atom).   **(5)**

4. (a) State and explain Gauss's law in electro statics. What are electric flux ϕ_E, magnetic
    flux ϕ_B and the gravitational flux ϕ_G? Write down Gauss's law relating them.   **(10)**

    (b) Derive Coulomb's law from Gauss's law and hence show that the two laws are
    equivalent.   **(15)**

    (c) Fig. 4c shows portions of two large parallel, non-conducting sheets, each with fixed
    uniform charge on one side. The magnitude of surface charge densities are
    $\sigma_{(+)}$ = 6.8 $\mu c/m^2$ for the positively charged sheet and $\sigma_{(-)}$ = 4.3 $\mu c/m^2$ for the negativity
    charged sheet. Find the electric field $\vec{E}$ (i) to the half of the sheets, (ii) between the
    sheets, and (iii) to the right of the sheets.   **(10)**
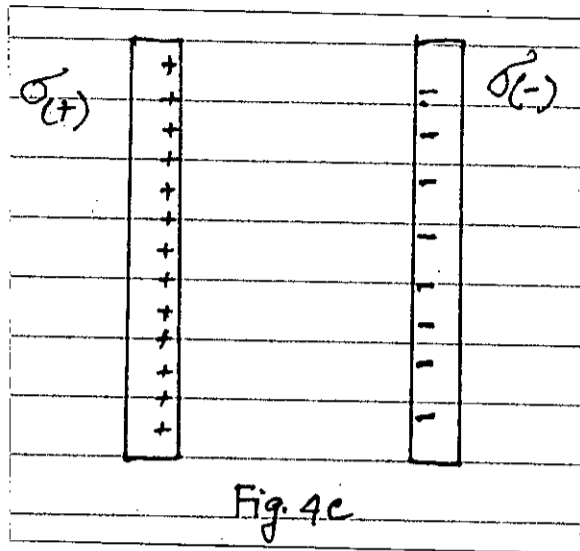
PHY 165

<u>Contd... Q. No. 4 (c)</u>

Fig. 4c

SECTION - B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define electric potential. How is the electric potential related to electric field $\vec{E}$? **(10)**
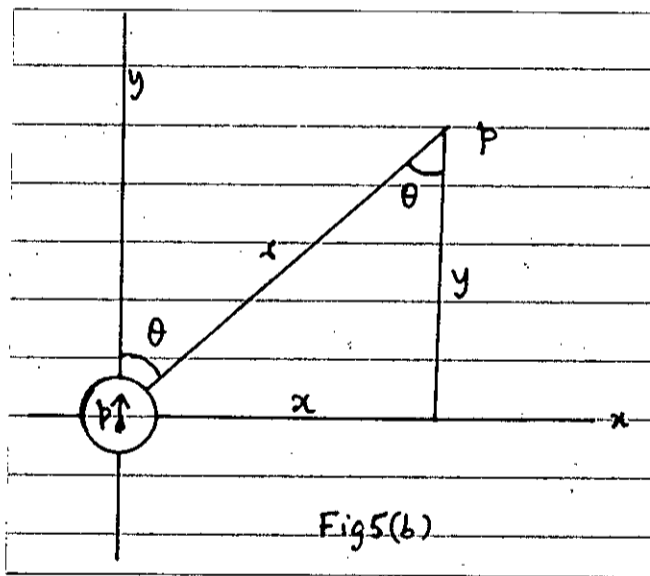
    (b) **(15)**

Fig 5(b)

Fig 5b shows a distant point P in the field of a dipole located at the origin of an xy-axis system. Derive an expression for the electric potential V and hence calculate $\vec{E}$ as a function of position.

(c) Two thin insulated concentric conducting spheres of radii R_1 And R_2 carry charges q_1 And q_2. Derive expressions for E(r) and V(r), where r is the distance from the center of the spheres. Plot E(r) and V(r) from r = 0 to r = 4.0 meters for R_1 = 0.50 meter, R_2 = 1.0 meter, q_1 = + 2.0 × 10^{-6} coul, and q_2 = + 1.0 × 10^{-6} coul. **(10)**

PHY 165

6. (a) Discuss Faraday's law of electromagnetic induction. What are magnetic damping and Eddy current? Give an example of magnetic damping. **(10)**

(b) What is time varying magnetic field? Discuss what happens when a conducting loop is placed in a time-varying field? In Fig 6b below, let B be increasing at the rate $\frac{dB}{dt}$. Let R be the radius of the cylindrical region in which the magnetic field is assumed to exist. What is the magnitude of the electric filed E at any radius r? Assume that $\frac{dB}{dt} = 0.10$ weber/m^2-sec and R = 10 cm (i) calculate flux ϕ_B for r < R (ii) calculate flux ϕ_B for r > R through the loop. Plot the magnitude of E(r) for the numerical values given. **(15)**

Fig 6b.
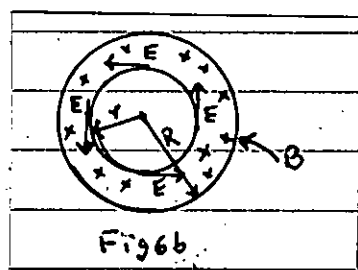
(c) A 100 turns of insulated copper wire are wrapped around an iron cylinder of cross-sectional area 0.001 m^2 and are connected to a resistor. The total resistance in the circuit is 10 ohms. If the longitudinal magnetic induction in the iron changes from 1 weber/m^2 in one direction to 1 weber/m^2 in the opposite direction, how much charge flows through the circuit? **(10)**

7. (a) What do you mean by quantum mechanical operators? Briefly explain the role of an operator in quantum mechanics. **(5)**

(b) Derive an expression for the momentum operator from the expectation value of position. Hence show how the operators corresponding to different physical quantities can be obtained from the position operator and momentum operator. **(15)**

(c) At any time t, a particle is represented by the wavefunction **(15)**

$$\psi(x,t) = Ae^{-\lambda|x|}e^{-i\omega t}$$

where λ and ω are real position constants.

(i) Normalize $\psi(x,t)$ (ii) Determine the expectation value of position and momentum.

8. (a) What do you mean by stationary states? **(5)**

(b) By considering proper approximations derive time independent Schrödinger equation from time dependent Schrödinger equation. Hence formulate a general expression for the stationary state (wave function). **(13)**

(c) With proper quantum mechanical reasoning explain why it is not possible for an electron with zero or negative energy to stay inside a square well of infinite potential? **(17)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2   B. Sc. Engineering Examinations 2017-2018

Sub: **HUM 127** (Sociology, Science and Technology)

Full Marks: 210   Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks

SECTION — A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) 'Sociology is a categorical and not a normative discipline'- discuss.   **(10)**

    (b) Discuss the conflict theoretical perspective of sociology.   **(15)**

    (c) Briefly explain the social impact of industrial revolution for developing Sociology

    as an independent discipline.   **(10)**

2. (a) What do you understand by social inequality? Discuss various systems of social

    stratification.   **(20)**

    (b) Discuss Karl Marx's theory of class differences.   **(15)**

3. (a) Define social control, conformity and obedience.   **(10)**

    (b) Define crime. Briefly discuss different types of crime.   **(10)**

    (c) Discuss the socio-cultural causes of juvenile delinquency.   **(15)**

4. Write short notes on any three of the following: **(35)**

    (a) Dominant ideology.

    (b) Technology and ideology.

    (c) Subculture and counterculture.

    (d) Ethnocentrism.

SECTION - B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define global warming. What are the negative impacts of global warming?   **(10)**

    (b) Explain the significance and role of physical environment in social development.   **(15)**

    (c) Briefly discuss the 4R's with examples.   **(10)**

HUM 127

6.   (a) Discuss the characteristics of pre-industrial, industrial and post-industrial societies.   **(10)**

   (b) How do you define deindustrialization and industrialization? What impacts did the industrial revolution have on societies?   **(15)**

   (c) Illustrate the negative impacts of capitalism on a society.   **(10)**

7.   (a) What is the main difference between urbanization and urbanism?   **(8)**

   (b) Write down the factors that have led to the growth of cities.   **(15)**

   (c) Critically discuss how the technological developments have changed our social and family life.   **(12)**

8.   Write short notes on any THREE of the following: **(35)**

   (a) Changing functions of the modern nuclear family

   (b) Sources of social change

   (c) Demographic Transition theory

   (d) Causes of human migration.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-1/T-2 B. Sc. Engineering Examinations 2017-2018
Sub : **HUM 277** (Fundamentals of Economics)
Full Marks : 210   Time : 3 Hours
The figures in the margin indicate full marks.
Symbols indicate their usual meaning.
USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A
There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Define demand function.   **(5)**

    (b) What are the factors that influence the shifting of the demand curve?   **(10)**

    (c) How would you derive the market demand curve of a commodity? Explain graphically. **(10)**

    (d) What are the determinants of supply?   **(10)**

2. (a) What are the determinants of price elasticity of demand? Show that any straight line
    supply curve which passes through the origin has a unitary elasticity of supply.   **(10)**

    (b) What is the relation between price elasticity of demand and total revenue? There are
    two parallel straight line demand curves. Show that the curve which is nearer to the origin
    has a higher price elasticity of demand at any point. Explain graphically.   **(15)**

    (c) From the following table, calculate elasticity of demand if you move from point A to
    C and explain what you understand from the result.   **(10)**

POINT	P_x	Q_y
A	500	120
B	600	150
C	700	180

3. (a) Explain consumer's equilibrium with the help of budget line and indifference curve. **(10)**

    (b) Make a hypothetical indifference schedule and plot the curve. Explain the properties
    of an indifference curve.   **(15)**

    (c) From the following budget line and the utility function, calculate the amount of two
    commodities that maximizes satisfaction. What is the maximum amount of satisfaction? **(10)**

    $$3000 = 25X + 35Y$$
    $$U = 1500\, X^{0.6} Y^{0.7}$$

4. (a) In case of calculating GDP, what is the treatment of Inventories and Used goods?
    Explain all possible cases.   **(10)**

    (b) What is GDP? Differentiate between Real GDP and Nominal GDP; GDP and GNP.   **(15)**

    (c) Demonstrate the relationship between Money Supply and Price Level with the help of
    the Quantity Theory of Money.   **(10)**

HUM 277 (EEE)

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Define total, average and marginal cost. Why does marginal cost increase as output increase? **(5)**

(b) Fill the gaps on the table below **(15)**

Quantity (q)	Total Cost	Variable Cost	Fixed Cost	Average Total Cost	Average Fixed Cost	Average Variable Cost	Marginal Cost
5						6	10
6	85						
7				15			
8					5		25
9		120					

[Hint: marginal cost of q(6) = total cost of q(6) – total cost of q(5)]

(c) Draw average cost (AC) and marginal cost (MC) from above table (in question b) and discuss the relationship between the AC and MC. **(15)**

6. (a) Discuss the characteristics and explain profit maximization of a perfectly competitive firm graphically. What type of profit will sustain in this market in long-run and why? **(15)**

(b) Why monopoly arises in the market? Show the equilibrium of monopoly market graphically and explain. **(15)**

(c) Explain deadweight loss of monopoly market. **(5)**

7. (a) What is National Income Accounts Identity? Briefly describe the components of aggregate expenditure: **(10)**

(b) Derive IS curve using the Keynesian Cross and the Investment Function. How does IS Curve shift in response to an increase in government purchase? **(12.5)**

(c) Derive LM curve from the Theory of Liquidity Preference. What will be the change in interest rate and output/income if the Central Bank takes a Contractionary Monetary Policy? Show the scenario diagrammatically. **(12.5)**

8. (a) How demand for factors is determined in a classical economy? Explain the concept using demand for labor. **(15)**

(b) "In the Solow Model, the steady state represents the long-run equilibrium of the economy" justify the statement. **(10)**

(c) What is the Golden Rule level of capital? Explain with the help of a diagram. **(10)**

L-1/T-2/EEE   Date : 25/03/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2   B. Sc. Engineering Examinations 2017-2018

Sub : **MATH 257** (Ordinary and Partial Differential Equations)

Full Marks: 210   Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks. The questions are equal value.

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) Find the differential equation by eliminating arbitrary constants A, B from the
    equation $xy = Ae^x + Be^{-x} + x^2$.   **(11)**

    (b) Solve: $(x + y)^2 \left(x \dfrac{dy}{dx} + y \right) = xy \left(1 + \dfrac{dy}{dx} \right)$.   **(12)**

    (c) Solve: $\dfrac{dy}{dx} = \dfrac{6x - 4y + 3}{3x - 2y + 1}$.   **(12)**

2. (a) An inductance of 2 henries and a resistance of 20 ohms are connected in a series
    with an e.m.f. E= 100 volts. If the current is zero when t = 0, find the current at end of
    .01 sec.   **(12)**

    (b) Find the integrating factor of $y(xy + 2x^2y^2)dx + x(xy - x^2y^2)dy = 0$ and hence
    solve it.   **(12)**

    (c) Solve: $(1 - x^2)\dfrac{dy}{dx} + xy = xy^2$.   **(11)**

3. Solve the following differential equations:
    (a) $(D^2 + 2D + 1)y = 2x + e^x$.   **(12)**
    (b) $(D^2 - 2D + 1)y = xe^x \sin x$.   **(12)**
    (c) $(x^2D^2 - xD + 4)y = \cos \log x + x \sin \log x$.   **(11)**

4. (a) Apply the method of variation of parameter to solve $4\dfrac{d^2y}{dx^2} + 36y = \cos ec3x$.   **(12)**

    (b) Use the method of factorization of operators to solve the equation
    $(x + 1)\dfrac{d^2y}{dx^2} + x\dfrac{dy}{dx} - \dfrac{dy}{dx} - 2y = 0$.   **(12)**

    (c) Solve: $x\dfrac{d^2y}{dx^2} + x\left(\dfrac{dy}{dx}\right)^2 - \dfrac{dy}{dx} = 0$.   **(11)**

SECTION - B

There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Find the series solution of the following differential equation by using the method
    of Frobenius: **(25)**

    $$2x(1 - x)\dfrac{d^2y}{dx^2} + (1 - x)\dfrac{dy}{dx} + 3y = 0.$$

MATH 257
Contd... Q. No. 5

(b) Form a partial differential equation by eliminating the arbitrary function ϕ from $\phi\left(\tan x + \sin^{-1} y - \log z, \, e^x - \sec y + z^3\right) = 0.$ **(10)**

6. (a) Find the integral surface of the partial differential equation $(2xy - 1)p + (z - 2x^2)q = 2(x - yz)$ which passes through the line $x = 1, y = 0.$ **(12)**

(b) Find the complete and singular integrals of the following partial differential equation $2xz - px^2 - 2qxy + pq = 0.$ **(12)**

(c) Using Charpit's method find the complete integral of the partial differential equation $q = (z + px)^2.$ **(11)**

7. Solve the following higher order partial differential equations:

(a) $\left(D_x^2 - D_x D_y - 6D_y^2\right)z = xy.$ **(11)**

(b) $\left(D_x^2 - D_x D_y - 2D_y^2 + 2D_x + 2D_y\right)z = e^{3x+4y} + \sin(2x + y).$ **(12)**

(c) $\left(D_x^2 - 4D_x D_y + D_x - 1\right)z = e^{x+y}\cos(x + y).$ **(12)**

8. (a) Solve the following higher order partial differential equation: **(15)**
$$\left(x^2 D_x^2 - 2xy D_x D_y - 3y^2 D_y^2 + xD_x - 3yD_y\right)z = x^2 y \sin(\log x^2).$$

(b) The vibrations of an elastic string of length l are governed by the following wave equation **(20)**

$$\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$$

under the condition: $u(0,t) = 0, \ u(l,t) = 0$

$$\frac{\partial u}{\partial t} = 0 \text{ when } t = 0 \text{ and } u(x,0) = \sin^3 \frac{\pi x}{l}.$$

Find the displacement $u(x,t)$ of the string for $t > 0.$

L-1/T-2/EEE   **Date : 14/03/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-2   B. Sc. Engineering Examinations 2017-2018

Sub : **EEE 105** (Electrical Circuits II)

Full Marks: 210   Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

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SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1.   (a) Determine the input impedance Z_{in} in the circuit for Q.1a.   **(15)**

(b) Assuming that the circuit of Figure for Q. 1b is in steady state before switching,
Find $v(t)$ for $t > 0$.   **(20)**

2.   (a) Analyze the circuit of Figure for Q. 2a to determine whether a value of X_c can be
found such that the output voltage is equal to twice the input voltage.   **(17)**

(b) In the circuit of Figure for Q. 2b, the switch closes at $t = 0$. If $R_1 = R_2 = 10\ \Omega$,
$C = 250\ \mu F$, $v_s = 100\sqrt{2}\ \sin(\omega t + \varphi)$ and $f=60$ Hz. Find current in R_3 after switching.
Assume that at the instant of switching $v_s = 0$ and its derivative is positive.   **(18)**

3.   (a) Determine the generalized form of expression of the steady-state voltage $v_0(t)$ and
from there calculate the first three terms for the circuit shown in Figure for Q. 3a if   **(20)**

$$v(t)=\frac{1}{2}+\sum_{n=1}^{\infty}\frac{1}{n\pi}(\cos n\pi -1)\sin nt\ \text{V}$$

Also calculate the power dissipated on the output 1 Ω resistance.

(b) Derive the general expression for instantaneous energy stored in a coupled circuit
of two inductor coil and define the upper limit of M.   **(15)**

4.   (a) The cast-iron core of Figure for Q. 4a is symmetrical. Determine current I. Use the
BH curve attached with the question.   **(13)**

(b) A cast steel magnetic circuit with N = 2500 turns, I = 200 mA, and a cross-sectional
area of 0.02 m² has an air gap of 0.00254 m. Assuming 90% of the mmf appears across
the gap, estimate the flux in the air gap. Use the BH curve attached with the question.   **(18)**

(c) Define power factor for a non linear load.   **(4)**

SECTION - B

There are **FOUR** questions in this section. Answer any **THREE**.

5.   (a) Design a low-Q series R-L-C resonance circuit such that the half-power frequencies
become 4 kHz and 9 kHz. Also determine the resonance frequency and the quality
factor of the circuit. How the quality factor of the circuit can be improved to 10
keeping the same resonance frequency and what would be the values of the bandwidth
and the half-power frequencies?   **(17)**

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Contd... Q. No. 5

(b) Explain the effect of the variations of resistances R_s and R_c on the resonance frequency for the resonance circuit shown in Fig. for Q. 5(b). Determine the resonance frequency and the power supply from the source if $V_m = 200V$, $R_s = 4\ \Omega$, $R_c = 10\ \Omega$, $L = 20$ mH and $C = 100\mu F$. **(18)**

6. (a) Derive the expressions of characteristics impedance and transmission constant for the T-section shown in Fig. for Q. 6(a). **(17)**

(b) Determine the type of the filter for the filter circuit shown in Fig. for Q. 6(b). Also determine the cut-off frequency/ frequencies. **(18)**

7. (a) Show that for transmission of the same amount of power from one place to another place, the required amount of copper cable in single phase system is 33.33% higher than that of the balanced three phase system. **(15)**

(b) An industry has the following three balanced loads with electricity connection of 440 V, 50 Hz with a-b-c phase sequence. **(20)**

Load1: 60 kW at 0.6 p.f. lagging; Load2: 90 kVAR at 0.8 lagging; Load3: 100 kW at 0.5 p.f. lagging.

Determine (i) real power and reactive power of the combined load, (ii) line current, and (iii) the kVAR rating and the value of the each capacitor if three capacitors are connected as Y to improve the overall p.f. to 0.9 lagging.

8. (a) The unbalanced load shown in Fig. for Q. 8(a) is connected to a 440 V, 50 Hz power supply with a-b-c phase sequence. Determine the line currents and the real power and reactive power supply to the load. **(18)**

(b) Due to the limitation of the range of the available wattmeters, power of two balanced three phase loads are measured individually by using the Two Wattmeter Method. For the Load1, the readings of the two wattmeters are $W_1 = 2000$ watts and $W_2 = 3000$ watts. For the Load2, the readings of the two wattmeters are $W_1 = 1800$ watts and $W_2 = 1200$ watts. Determine the Load1, Load2, and the total load with p.f. If the total power is measured with two wattmeters having higher range, what would be their readings? **(17)**

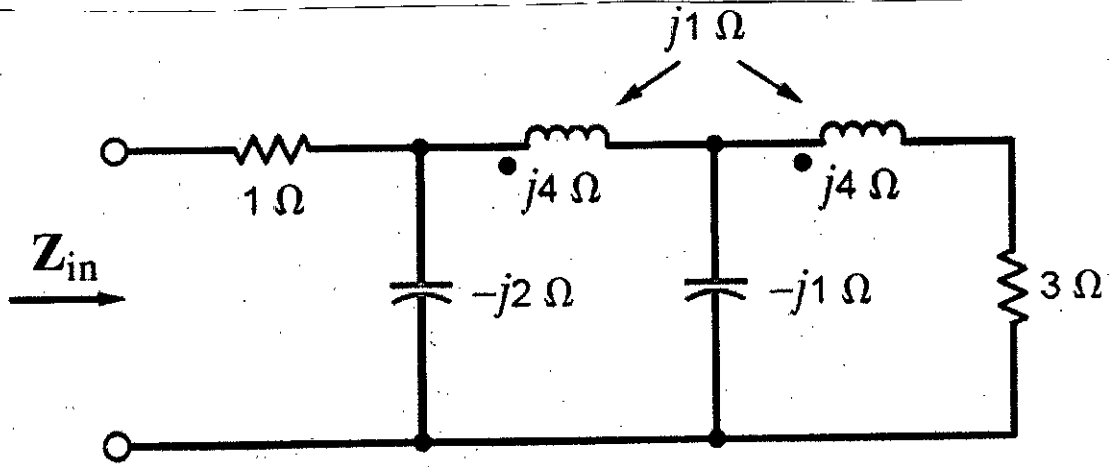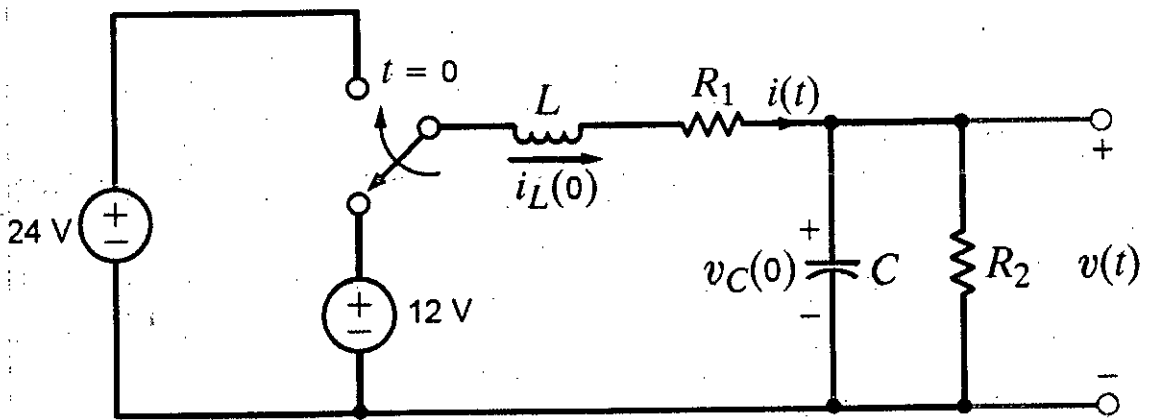---
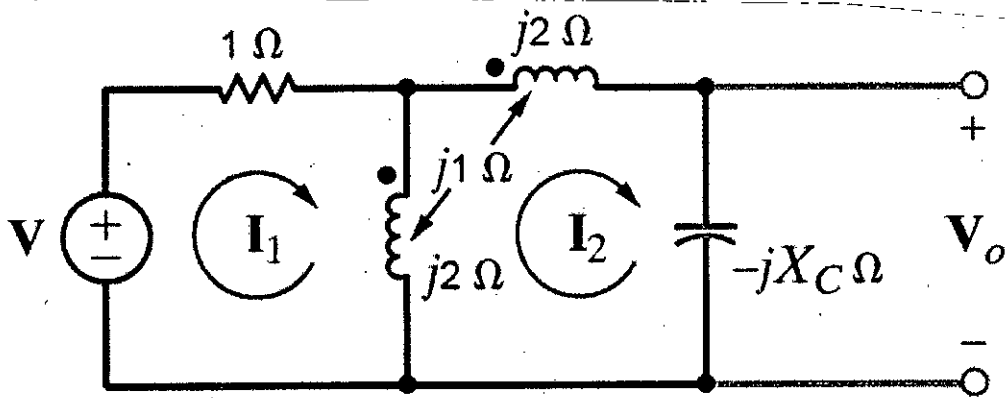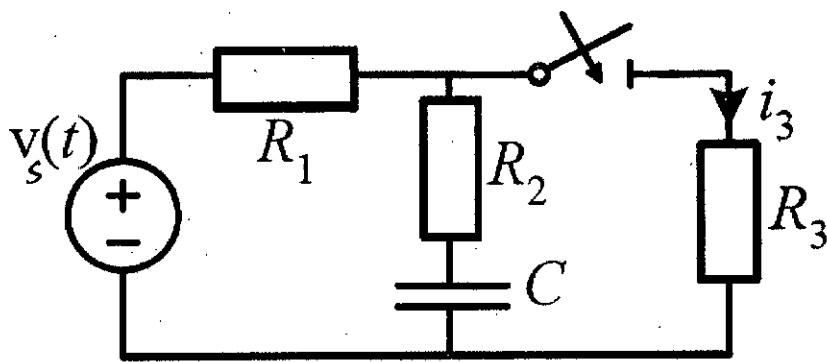
Figure for Q.1a
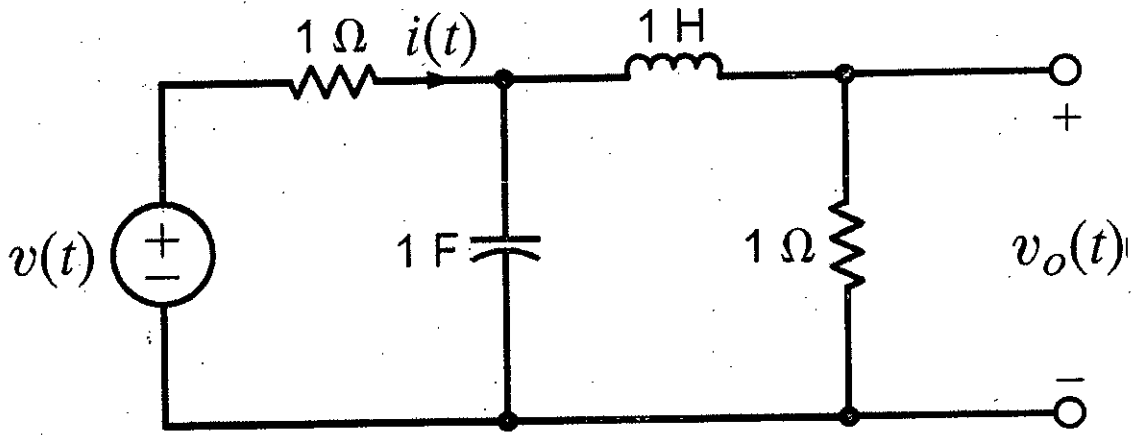

Figure for Q. 1b

Figure for Q. 2a

Figure for Q. 2b
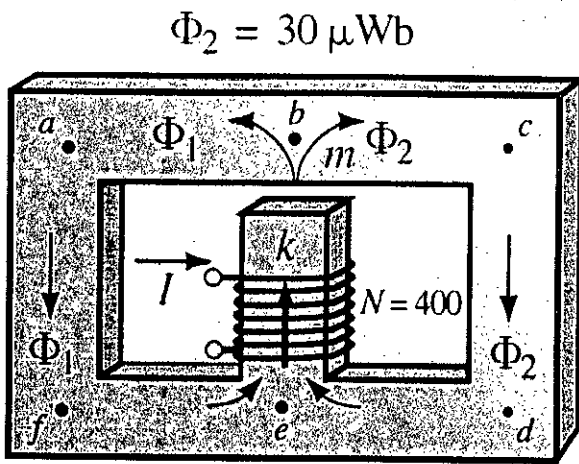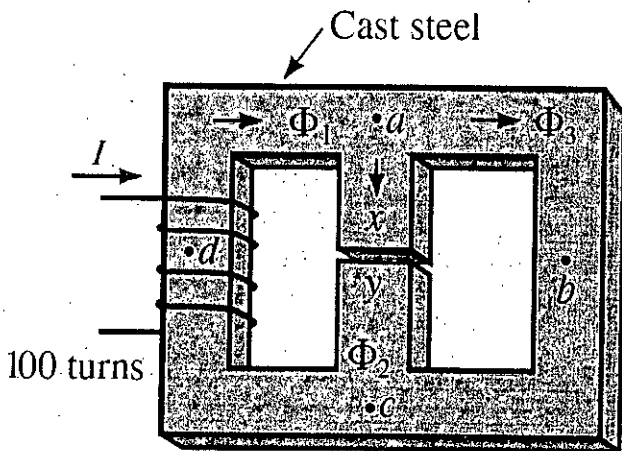
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Figure for Q. 3a

$\Phi_2 = 30\ \mu\text{Wb}$

$\ell_{ab} = \ell_{bc} = \ell_{cd} = 4$ cm
Gap: $\ell_g = 0.5$ cm
$\ell_{ek} = 3$ cm

Core dimensions: 1 cm × 1 cm

Figure for Q. 4a

Cast steel

$\ell_g = \ell_{xy} = 0.001$ m
$\ell_{abc} = 0.14$ m
$\ell_{cda} = 0.16$ m
$\ell_{ax} = \ell_{cy} = 0.039$ m
$A = 4$ cm^2 everywhere

100 turns

Figure for Q. 4b
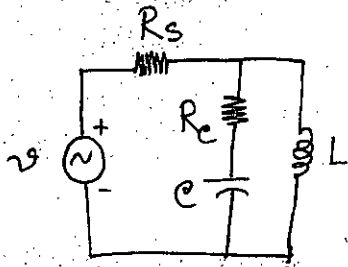
Fig. for Q.5(b)

$v = V_m \sin \omega_0 t$
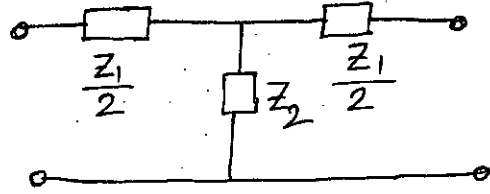
Fig. for Q.6(a)

Fig. for Q.6(b)
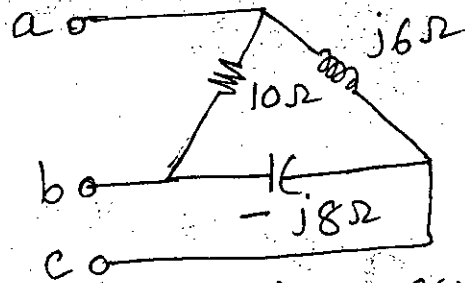
Fig. for Q.8(a)
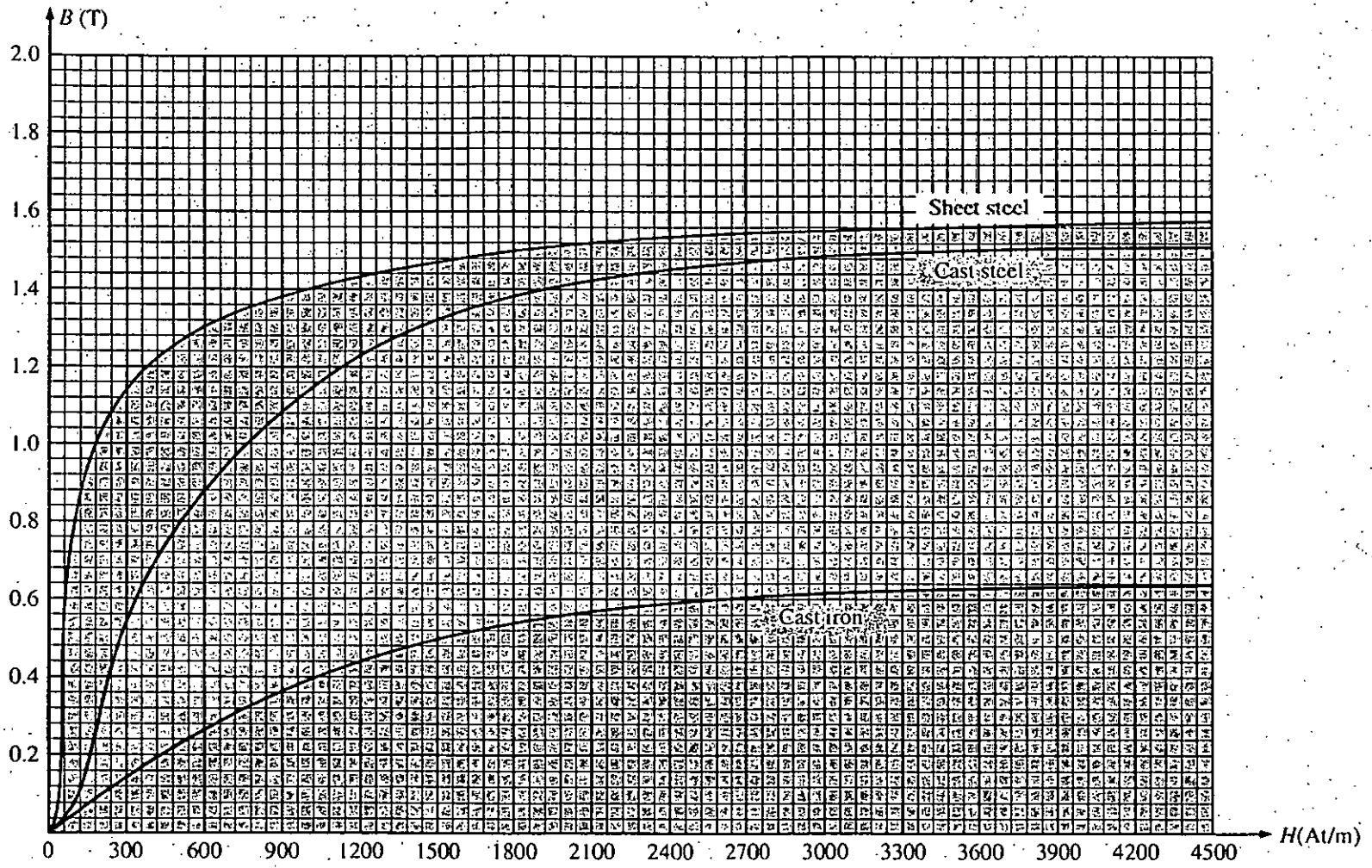
B-H magnetization curves for Sheet steel, Cast steel, and Cast iron. Vertical axis: B (T) from 0 to 2.0; horizontal axis: H (At/m) from 0 to 4500.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1   B.Sc. Engineering Examinations 2017-2018

Sub : **MATH 157** (Calculus I)

Full Marks: 210   Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

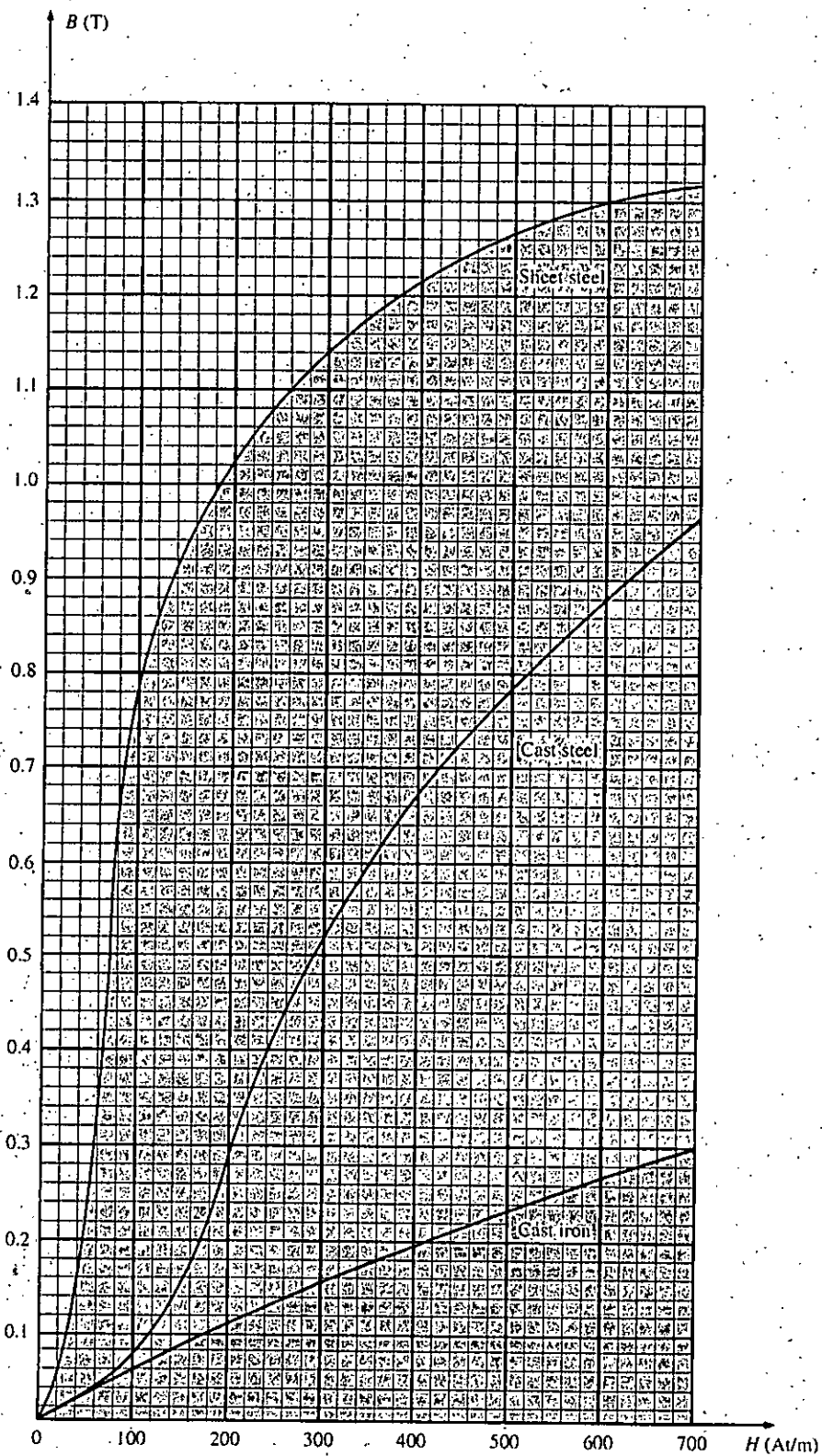### SECTION – A

There are **FOUR** questions in this section. Answer any **THREE**.

1. (a) A function is defined as $f(x) = x^2 \sin\dfrac{1}{x}$, for $x \neq 0$, $f(0) = 0$. Discuss the

    continuity and differentiability of $f(x)$ at $x = 0$. Also sketch the graph of $f(x)$.   **(15)**

    (b) On a sunny day, a 50 ft flagpole casts a shadow that changes with the angle of
    elevation of the Sun. Let s be the length of the shadow and β the angle of elevation of
    the Sun. Find the rate at which the length of the shadow is changing with respect to β

    when $\beta = 45^\circ$. Express your answer in units of feet/degree.   **(10)**

    (c) If $y = \sin\left(m\sin^{-1}x\right)$, then show that $\left(1 - x^2\right)y_{n+2} - (2n+1)xy_{n+1} + \left(m^2 - n^2\right)y_n = 0$.   **(10)**

2. (a) Write Mean Value theorem. In which case, this theorem is modified into Rolle's
    theorem? Suppose that two runners in a 100 m dash finish in a tie. Check whether they
    had the same velocity at least once during the race or not. Justify your answer.   **(15)**

    (b) Expand the function $(1+x)^m$ in Maclaurin's infinite power series stating the
    condition under which the expansion is valid.   **(10)**

    (c) An electrical circuit consisting of an electromotive force that produces a voltage V,
    a resistor with resistance R, and an inductor with inductance L. It is shown in electrical
    circuit theory that if the voltage is first applied at time $t = 0$, then the current I flowing
    through the circuit at time t is given by $I = V(1-e^{-Rt/L})/R$. What is the effect on the
    current at a fixed time t if the resistance approaches 0 (i.e., $R \to 0+$)?   **(10)**

3. (a) Write the necessary condition for which a function has maximum or a minimum
    values. How do you determine them? Find the altitude of the right cone of maximum
    volume that can be inscribed in a sphere of radius a.   **(18)**

    (b) State Euler's theorem of homogeneous function and prove it. If

    $x^2 + y^2 + z^2 - 2xyz = 1$ then find the value of $\left(\dfrac{dx}{\sqrt{1-x^2}} + \dfrac{dy}{\sqrt{1-y^2}} + \dfrac{dz}{\sqrt{1-z^2}}\right)$.   **(17)**

4. (a) Write the condition of determining tangents at the origin. If the tangent
    at (x_1, y_1) to the curve $x^8 + y^8 = a^8$ meets the curve again in (x_2, y_2), then find the

    value of $\left(\dfrac{x_2}{x_1} + \dfrac{y_2}{y_1}\right)$.   **(15)**

    (b) Find the evolute of the curve $x^{2/3} + y^{2/3} = a^{2/3}$.   **(10)**

    (c) Find all the asymptotes of $r^n \sin n\theta = a^n$, where $n > 1$.   **(10)**

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<u>SECTION - B</u>

There are **FOUR** questions in this section. Answer any **THREE**.

5. Evaluate the following integrals: **(11+12+12)**

(a) $\int \dfrac{1}{1-2\cos x+3\sin x}\ dx$

(b) $\int \dfrac{dx}{x^4+a^4}$

(c) $\int (2x-3)\sqrt{4x^2-4x-1}\ dx$

6. (a) Find a reduction formula for $I_n=\int \left(\sin^{-1}x\right)^n dx$ and hence obtain $\int \left(\sin^{-1}x\right)^3 dx$. **(13)**

   (b) Evaluate: **(10)**

   $$\underset{n\to\infty}{Lim}\left[\frac{n^{1/2}}{n^{3/2}}+\frac{n^{1/2}}{(n+5)^{3/2}}+\frac{n^{1/2}}{(n+10)^{3/2}}+\dots+\frac{n^{1/2}}{\{n+5(n-1)\}^{3/2}}\right].$$

   (c) Find the value of: $\displaystyle\int_{3}^{29} \dfrac{(x-2)^{2/3}}{(x-2)^{2/3}+3}\ dx$. **(12)**

7. (a) Evaluate: $\displaystyle\int_{0}^{\pi} \dfrac{x\sin x}{1+\cos^2 x}\ dx$. **(11)**

   (b) Find the value of $\displaystyle\int_{1}^{\infty} \dfrac{\sqrt{x}}{(1+x)^2}\ dx$. **(11)**

   (c) (i) Establish a relation between gamma and beta function. **(8)**

   (ii) Show that $\Gamma(n+1)=n\Gamma n$. **(5)**

8. (a) Determine the area between the ellipse $x^2+2y^2=a^2$ and $2x^2+y^2=a^2$. **(15)**

   (b) Find the common area between the curves r = cos θ and r = sin θ. **(10)**

   (c) Find the surface area of the solid generated by revolving the cardioid r = a (1 + cos θ) about the initial line. **(10)**