SECTION - A

There are FOUR questions in this Section. Answer any THREE.

1. (a) Explain the process of emission of light by an atom. Calculate the largest wavelength found in the Balmer series of hydrogen. \((R = 1.097 \times 10^7/m)\). (15)
   (b) What are the limitations of Bohr atom model? (8)
   (c) Derive the Schrodinger wave equation. Mention the significance of \(\psi\) and \(\psi^2\). (12)

2. (a) What are transition elements? Write down the atomic numbers of 1st transition series. Discuss the important properties of the transition elements. (15)
   (b) Write short notes on:
      (i) Diamond and graphite.
      (ii) The noble gas elements. (10×2=20)

3. (a) Describe the condition favourable for the formation of ionic bond. (8)
   (b) What hybrid orbitals would be expected for the central atom of the following? (10)
      (i) XeF\(_2\) (ii) H\(_2\)O
      Explain their structures also.
   (c) Discuss the formation of O\(_2\) molecule according to valence bond theory and molecular orbital theory. Which one is better to explain the properties of O\(_2\) molecule? (10)
   (d) What are the conditions for the formation of a hydrogen bond? Discuss the properties of H\(_2\)O with reference to hydrogen bonding. (7)

4. (a) Define reversible and irreversible cells. Discuss various type of reversible electrodes. (16)
   (b) What is standard electrode potential? Is it safe to stir 1 M AgNO\(_3\) solution with a copper spoon? Explain your answer. (9)
   (c) Write the cell reactions of
      (i) SHE coupled with Ag/AgCl electrode
      (ii) Zn/Zn\(^{2+}\) electrode coupled with calomel electrode
      (iii) Leclanche dry cell
      (iv) Lead storage battery. (10)

Contd ......... P/2
CHEM 107

SECTION - 6

There are FOUR questions in this Section. Answer any THREE.

5. (a) Explain the effect of pressure on the solubility of gases in liquids. Why solubility of a gas in a given liquid decreases with rise in temperature? (8+3=11)

(b) State Raoult’s laws of b.p. elevation and derive the equation \( \Delta T_b = K_b m \), where \( \Delta T_b \) = elevation of boiling point, \( K_b \) = molal ebullioscopic constant and \( m \) = molality. (12)

(c) 0.562 g of naphthalene was dissolved in 30 g of carbon tetrachloride. If the normal boiling point of carbon tetrachloride is taken as 76.91°C, at what temperature the solution will boil at atmospheric pressure if \( K_b = 5.02 \)? (4)

(d) State the laws of osmotic pressure. Explain how osmotic pressure is analogous to gas pressure. (8)

6. (a) Define the terms phase, component and degrees of freedom. (6)

(b) Water and sulphur are one component system, but water has only one triple point whereas sulphur has three triple points. Explain it with the help of phase diagram. (14)

(c) Determine the number of phases, components and no. of degrees of freedom for the following system:
   (i) \( \text{NH}_4\text{Cl} \text{ (s)} \leftrightarrow \text{NH}_3 \text{ (g)} + \text{HCl} \text{ (g)} \)
   (ii) \( \text{N}_2\text{O}_4 \text{ (g)} \leftrightarrow 2 \text{NO}_2 \)

(d) Draw the phase diagram of a two component system where two components are completely miscible with each other in the liquid state and there is no chemical interaction between them: Explain the eutectic point present in the system. Why eutectic mixture is not a compound? (9)

7. (a) Discuss the preparation, properties and uses of PVC. What is the importance of plasticizer in polymer processing? (6+3=9)

(b) Write a short note on – (i) Chromophore (ii) Auxochrome (8)

(c) What is equilibrium constant? Derive the equation \( \Delta G^\circ = - RT \ln K \) (8+4=12)

(d) A buffer solution contains 0.2 g. mole of acetic acid and 0.25 g, mole of potassium acetate per dm³. Calculate the change in pH of the solution if 0.5 mL of 1N HCl is added to it. [ \( K_a = 1.8 \times 10^{-5} \) ] (6)

8. (a) How do you differentiate the order and molecularity of a reaction? (8)

(b) Derive an expression for the rate constant of a second order reaction. Explain two methods for the determination of reaction order. (10+8=18)

(c) How activation energy (\( E_a \)) can be calculated using Arrhenius equation? The rate constant of a reaction at 25°C is doubled on raising the temperature through ten degree. What is the activation energy of the reaction? (4+5=9)
SECTION - A
There are FOUR questions in this Section. Answer any THREE.

1. (a) Discuss the important conditions for the interference of light. Distinguish between constructive and destructive interference of light. (10)
(b) Describe with necessary theory of the Newton's rings method of measuring wavelength of light. (15)
(c) In a Newton's rings experiment the diameter of the 15th ring was found to be 0.590 cm and that of the 5th ring was 0.336 cm. If the radius of the plano-convex lens is 100 cm, calculate the wavelength of light used. (10)

2. (a) What is diffraction of light? Derive an expression for the intensity distribution due to Fraunhofer diffraction at a single slit and hence find the conditions for maxima and minima. (20)
(b) A parallel of light is incident normally on a narrow slit of width 0.2 mm. The Fraunhofer diffraction pattern is observed on a screen, placed at the focal plane of a convex lens of focal length 20 cm. Calculate the distance between the first two minima. (Assume $\lambda = 5 \times 10^{-5}$ cm and that the lens is placed very close the slit). (7)
(c) What is a grating? Define the resolving power of a grating. (8)

3. (a) State the Brewster's law. Show that at the polarizing angle of incidence, the reflected and refracted rays are mutually perpendicular to each other. (12)
(b) Explain the Malus' law. How will you orient the polarizer and the analyzer so that a beam of natural light is reduced to (i) 0.25 and (ii) 0.5 of its original intensity? (13)
(c) Write short notes on
   (i) Specific rotation and (10)
   (ii) Quarter and half wave plates.

4. (a) What are Lissajous figures? Derive a general expression for the resultant vibration of a particle simultaneously acted upon by two initially perpendicular simple harmonic vibrations, having the same frequency but different amplitudes and phase angles. Hence discuss the cases if phase difference are (i) $\pi/2$ and (ii) $\pi/4$. (15)
(b) Show that for a body executing simple harmonic motion, both the average potential energy and average kinetic energy are half of the total energy of the harmonic oscillator. (12)

Contd ........ P/3
The displacement of an oscillating particle having mass 4 kg at an instant \( t \) is given by \( y = 2 \sin 0.5t \), where \( y \) is in meters and \( t \) is in seconds. If its angular frequency become double, then calculate the average kinetic energy of that particle. (8)

**SECTION – B**

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

5. (a) What is meant by damped vibrations? (2)
   (b) Establish the second order differential equation for a body executing damped harmonic oscillation and hence obtain an expression for the displacement of that particle under this damped oscillatory motion. (15)
   (c) Show that the average total energy of the damped harmonic oscillator falls exponentially with time. (10)
   (d) The mass of a damped oscillator is 0.20 kg and spring constant is 80 N/m. The damping coefficient is \( b = 0.07 \) kg/sec. After how many oscillations its total energy will drop to one half of its initial value? (8)

6. (a) What are the requirements of a good auditorium? Derive expressions for the growth and decay of sound intensity inside an auditorium and hence obtain an expression for the reverberation time. (25)
   (b) A room is 32 feet wide by 65 feet long by 10 feet high. The ceiling is acoustic, the walls are plaster, the floor is concrete and there are 40 people in the room. Calculate (i) the number of reflections (n) per second and (ii) reverberation time. Assume that the sound absorption coefficients are: ceiling = 0.60, plaster = 0.03, concrete = 0.2 and absorbing power per person to be 0.5. (10)

7. (a) Explain the terms cardinal points and power of a lens. (9)
   (b) Define equivalent lens and equivalent focal length. Derive an expression for the focal length of a system of two coaxial thin lenses placed in air and separated by a distance. (20)
   (c) Two similar thin convex lenses of focal lengths 10 cm each are coaxial and 5 cm apart. Find the equivalent focal length and the position of principal points. Also find the position of the object for which the image is formed at infinity. (6)

8. (a) What are the methods to minimize spherical aberration? How is spherical aberration minimized when two thin lenses are placed at a distance form each other? (10)
   (b) Explain what is meant by chromatic aberration in lens. Derive and discuss the condition of achromatism for two thin lenses separated by a distance. (20)
   (c) Two thin lenses of focal length \( f_1 \) and \( f_2 \) separated by a distance, \( d \) have an equivalent focal length 50 cm. The combination satisfies the conditions for minimum spherical aberration and is also achromatic. Find the values of \( f_1, f_2 \) and \( d \). Assume that both lenses are of same material. (5)
L-1/T-1/MME

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-1/T-1  B. Sc. Engineering Examinations 2010-2011

Sub: MATH 171 (Calculus and Differential Equation)

Full Marks: 210  Time: 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Consider the function

\[ f(x) = \begin{cases} \sqrt{\frac{x + \frac{1}{4}}{4}}, & -\frac{1}{4} \leq x \leq 0 \\ \frac{x - \frac{1}{2}}{2}, & 0 < x \leq 1 \\ x - 1, & x > 1 \end{cases} \]

(i) Find the points where \( f(x) \) is not continuous.

(ii) Discuss the differentiability of \( f(x) \) at \( x = 0 \) and \( x = 1 \).

(iii) Find the area under the curve \( f(x) \) using geometric formula over \([0, 2]\). Also sketch the graph.

(b) Find \( \lim_{x \to e} \frac{1}{1 - \ln x} \).

2. (a) Find \( \frac{d^n}{dx^n} (\sin^5 x \cos^3 x) \).

(b) If \( F(v^2 - x^2, v^2 - y^2, v^2 - z^2) = 0 \) and \( v = f(x, y, z) \), then find the value of \( \frac{1}{x} \frac{\partial v}{\partial x} + \frac{1}{y} \frac{\partial v}{\partial y} + \frac{1}{z} \frac{\partial v}{\partial z} \) in terms of \( v \).

(c) What is the degree of \( \tan \) considering it as homogeneous function, where \( u = \tan^{-1} \frac{x + y}{\sqrt{x^2 + y^2}} \). Verify Euler's theorem for \( \tan \) and find the value of \( x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} \).

3. (a) A farmer can afford for buying 8800 ft of wire fencing. He wishes to enclose a rectangular field of largest area. What should be the dimension of the field?

(b) Find the area of the triangle formed by the coordinate axes and the tangent at \( \theta = \pi/4 \) to the curve \( x = 27 \cos^3 \theta, y = 27 \sin^3 \theta \).

(c) Find the angle of intersection of two curves \( x^2 - y^2 = a^2 \) and \( x^2 + y^2 = a^2/2 \).

Contd ........... P/2
MATH 171

4. Evaluate the following integrals:
   (a) \[ \int \frac{dx}{(2x + 3)\sqrt{x^2 + 5x + 4}} \]
   (b) \[ \int \frac{dx}{\cos x + 5 \sin x + 2} \]
   (c) \[ \int \tan^{-1} \left( \frac{1-x}{1+x} \right) \, dx \]

SECTION – B

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

5. Evaluate the following:
   (a) \[ \int_{0}^{\frac{\pi}{2}} \frac{dx}{1 + \cot x} \]
   (b) \[ \int_{0}^{\pi} \frac{x}{a^2 \cos^2 x + b^2 \sin^2 x} \, dx \]
   (c) \[ \int_{0}^{\frac{\pi}{2}} \ln (1 + \cos x) \, dx \]

6. (a) Find the area of the curve \( \left( \frac{x}{a} \right)^{\frac{3}{2}} + \left( \frac{y}{b} \right)^{\frac{3}{2}} = 1 \).

   (b) Find the volume of the solid generated by the revolution of the loop of the curve \( y^2 (a - x) = x^2 (a + x) \) about x-axis.

7. Solve the following differential equations:
   (a) \( (x^3 + y^2) \sqrt{x^2 + y^2} \, dx - xy \sqrt{x^2 + y^2} \, dy = 0 \)
   (b) \( \frac{dy}{dx} + \frac{1}{x} \tan y = \frac{1}{x^2} \tan y \sin y \)
   (c) \( 2y (x^2 - y + x) \, dx + (x^2 - 2y) \, dy = 0 \)

8. Solve the following differential equations:
   (a) \( (D^2 - 4D + 4) y = 3x^2 e^{2x} \cos 2x \)
   (b) \( (x^2 D^2 + 3xD + 1) y = \frac{1}{(1-x)^2} \)
   (c) \( x^2 p^2 + xyp - 6y^2 = 0 \), where \( p = \frac{dy}{dx} \)
1. (a) Find the equivalent resistance $R_{eq}$ in the network shown in fig 1(a) (15)

(b) Using nodal analysis find the node voltages of the circuit in fig 1(b) (20)
2. (a) Using superposition theorem find \( i \) for the circuit in fig 2(a) (20)

![Circuit Diagram](image)

(b) Find \( I_0 \) in the circuit in fig 2(b) (15)

![Circuit Diagram](image)

3. (a) Find the equivalent resistance \( R_{eq} \) for the network left to a-b shown in fig 3(a) (15)

![Circuit Diagram](image)

Contd ....... P/3
(b) Find the power dissipated in 2 Ω resistor for the circuit shown in fig 3(b) (20)

4. (a) Find the voltage \( V_x \) for the circuit shown in fig 4(a) using supermesh analysis. (20)

(b) Find the thevenin equivalent circuit for the network left to a-b in fig 4(b). (15)
SECTION – B

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

5. (a) Determine the value of current \( I \) required to establish a magnetic flux of \( \phi = 0.016 \text{ Wb} \) in the magnetic circuit shown in Fig. for Q 5(a). Cast steel core is used in the circuit. Cross-sectional area = 16 sq in. throughout. The B-H characteristics chart is attached with the ques paper.

![](image)

(b) One motor takes 250 amperes at 0.8 power factor lag while another motor takes 50 KW at 0.5 leading power factor from a line of 220 volts. What is the resultant line current for these two motors? What is the power factor of the combined loads? Is it leading or lagging?

6. (a) A voltage \( v = 200 \cos (157t + 30^\circ) \) Volts is applied to a particular circuit element and it is found that \( i = 5 \sin (157t - 150^\circ) \) Amperes. Sketch the \( v \) and \( i \) waves. Find the nature and magnitude of the circuit parameters.

(b) Find the expression of instantaneous power delivered to RL branch where the phase shift between \( v(t) \) and \( i(t) \) is 0. Prove that the volt-amperes of the circuit is \( \frac{V_m I_m}{2} \), where \( V_m \) and \( I_m \) are the maximum value of the sinusoidal variation of voltage and current respectively.

Contd .......... P/5
7. (a) Draw the phasor diagram for the circuit shown in Fig. for Q 7(a) displaying the quantities $v_S$, $v_R$, $v_C$, $i$, $i_1$ and $i_2$. Choose arbitrary magnitudes for all the quantities. (15)

(b) If the current shown in Fig. for Q 7(b) flows through a 5-ohm resistance, how much heat energy is produced each cycle? (15)

(c) Define form factor and crest factor. (5)

8. (a) The voltage applied to two parallel branches is $40\angle 80^\circ$ volts. The current through branch 1 is $5\angle 30^\circ$ amperes, and the current through branch 2 is $(-6 + j8)$ amperes. Find the real power and the reactive volt-amperes supplied to the parallel combination by the method of conjugates. (14)

(b) When C is varied to produce series resonance why does the maximum drop across the capacitor occur before resonance? (7)

(c) As L is varied to produce resonance in a series circuit containing $R = 100$ ohms, $C = 13.26 \mu F$ and $f = 60$ Hz, find the voltage drop across L at resonance and also when the drop across L is a maximum if 1000 volts are impressed. (14)
B-H curve for § 5(a)
SECTION – A

There are FOUR questions in this Section. Answer any THREE.

The questions are of equal value.

1. (a) Discuss the procedure to conduct tensile test.
   (b) Draw a typical stress-strain diagram for a tensile test on mild steel. Discuss the information that may be obtained from such a test.

2. (a) Define hardness. Discuss the Brinell hardness test and describe the precautions which must be taken in its operation.
   (b) Draw a neat phase diagram for two metals (A, B) which are mutually soluble in both solid and liquid states.
   For an alloy containing 30 pet B find:
   (i) the temperature of initial solidification
   (ii) the temperature of final solidification.

3. (a) What is a unit cell? Differentiate between a unit cell and a primitive cell. Give examples, if necessary.
   (b) Determine the atomic packing factor (Packing Density) for a face centred cubic cell.

4. (a) Differentiate between different types of materials on the basis of bonds that exists between them.
   (b) Explain the nature of semi-conductors. Differentiate between different types of semiconductors.

Contd .......... P/2
MME 131

SECTION – B
There are FOUR questions in this Section. Answer any THREE.
The figures in the margin indicate full marks.

5. (a) Differentiate between hot working and cold working. Mention advantages and disadvantages of each process. (10)
(b) Classify the fabrication techniques of metals and alloys. Describe, with neat sketches, the types of forming operations. (20)
(c) What is power metallurgy technique? Mention various materials that are given the desired shape by power method. (5)

6. (a) Distinguish between 'drying and firing' during processing of ceramics. (8)
(b) What are the general characteristics of polymer? Discuss the divisions of polymers depending on their elevated temperature characteristics. (15)
(c) Illustrate, with suitable figures, the basic polymerization reactions. (12)

7. (a) Explain how metal degrades by galvanic corrosion. How can galvanic corrosion be prevented? (15)
(b) For intergranular corrosion, describe why, where and the conditions under which the corrosion occurs. (10)
(c) Which corrosion protection method do you suggest for a buried steel pipe? Describe the method. (10)

8. (a) Differentiate between ores and minerals. What are the sources of scrap metals? (10)
(b) Write the steps involved in hydrometallurgical processing. (5)
(c) Define electrowinning and electorefining. With suitable diagrams, describe the different situations involved in electrowinning of metals depending on their reactivity. (20)