Section-A (Answer any THREE questions)

1 (a) Define and provide examples of active and passive circuit elements. 1
(b) What are the independent and dependent sources? Write down the names of different types of dependent sources. 2.75
(c) State Kirchoff’s voltage and current laws. 2
(d) Find currents and voltages shown in the circuit of Fig. 1d. 3

\[ \begin{align*}
10 \text{ V} & \quad i_2 \quad 4 \text{ V} \\
4 \text{ V} & \quad + \quad 8 \text{ V} \\
8 \text{ V} & \quad + \quad 6 \text{ V} \\
\end{align*} \]

Fig. 1d

2 (a) Find the equivalent resistance \( R_{eq} \) in the circuit of Fig. 2a with terminals a and b (i) open circuited and (ii) short circuited. 3
(b) How can you determine currents in each branch when three resistors are connected in parallel? 2
(c) For the bridge network in the circuit of Fig. 2c, find the equivalent resistance in a-b terminal and total current \( i \). 3.75

\[ \begin{align*}
120 \text{ Ω} & \quad 100 \text{ Ω} \\
R_{eq} & \quad 75 \text{ Ω} \\
\end{align*} \]

Fig. 2a

\[ \begin{align*}
13 \text{ Ω} & \quad 24 \text{ Ω} \\
20 \text{ Ω} & \quad 10 \text{ Ω} \\
50 \text{ Ω} & \quad 30 \text{ Ω} \\
\end{align*} \]

Fig. 2c

3 (a) Write the nodal equations for the nodes \( e_1 \) and \( e_2 \) of the circuit in Fig. 3a. 1
(b) In the circuit of Fig. 3b. (i) Find the current \( i_2 \) using mesh analysis. (ii) Find the power supplied by the dependent current source. 2
(c) Use superposition to find the current \( i_x \) from the circuit in Fig. 3c. 2.75
(d) Use nodal analysis to find the current \( i_x \) from the circuit in Fig. 3d. 3

\[ \begin{align*}
V & \quad R_1 \\
e & \quad 4 \text{ kΩ} \\
e & \quad 2 \text{ kΩ} \\
e & \quad 2 \text{ kΩ} \\
\end{align*} \]

Fig. 3a

\[ \begin{align*}
i & \quad 4 \text{ A} \\
i & \quad 2 \text{ A} \\
30 \text{ V} & \quad 15 \text{ A} \\
8 \text{ Ω} & \quad 8 \text{ Ω} \\
\end{align*} \]

Fig. 3b

\[ \begin{align*}
i & \quad 3 \text{ A} \\
R_{L} & \quad 20 \text{ Ω} \\
\end{align*} \]

Fig. 3c

\[ \begin{align*}
i & \quad 6 \text{ Ω} \\
2 \text{ Ω} & \quad 3 \text{ Ω} \\
24 \text{ V} & \quad \text{ } \\
\end{align*} \]

Fig. 3d

4 (a) State and prove superposition theorem for dc circuit analysis. 4.75
(b) Find the Norton’s equivalent circuit for the network in Fig. 4b. 4

\[ \begin{align*}
4 \text{ Ω} & \quad 7 \text{ V} \\
8 \text{ Ω} & \quad 6 \text{ Ω} \\
\end{align*} \]

Fig. 4b
Section-B (Answer any THREE questions)

5 (a) What do you mean by energy storage passive circuit elements?  
(b) List the properties of inductor and capacitor.  
(c) Assuming that the capacitors are initially uncharged, find \( v_o(t) \) in the circuit of Fig. 5c.  
(d) Determine \( v_c, i_L \) and the energy stored in the capacitor and inductor in the circuit of Fig. 5d under dc conditions.

6 (a) What do you mean by first order circuits and why are they named so?  
(b) Derive the equation for the output response of a source free RC circuit and hence define time constant, \( \tau \).  
(c) The switch in the circuit in Fig. 6c has been closed for a long time. It is opened at \( t = 0 \). Find the inductor current \( i_L(t) \) for \( t < 0 \) and \( t > 0 \) of the circuit in Fig. 6c.  
(d) The switch in the circuit in Fig. 6d has been closed for a long time. It is opened at \( t = 0 \). Find the capacitor voltage \( v_c(t) \) for \( t > 0 \).

7 (a) What do you mean by the transient response of a 2\textsuperscript{nd} order system.  
(b) Draw the overdamped, underdamped, and critically damped response of a 2\textsuperscript{nd} order system.  
(c) The switch in the circuit of Fig. 7c has been closed for a long time. It is opened at \( t = 0 \). Find the current \( i_L(t) \) for \( t > 0 \) and the total energy dissipated in the 120 \( \Omega \) resistor after the switch is opened.  
(d) How do you convert a galvanometer into a dc voltmeter?

8 (a) Define permeability and reluctance.  
(b) Draw the magnetic hysteresis loop of a ferromagnetic material and show the following: saturation magnetization, coercive force and residual flux density.  
(c) Find the mmf (NI) required to establish a flux \( \Phi = 80,000 \) lines in the magnetic circuit of Fig. 8c. Find the permeability of each material. [use the B-H curve provided herewith]  
(d) For the series-parallel magnetic circuit of Fig. 8d, find the value of \( I \) required to establish a flux in the gap \( \Phi_g = 2 \times 10^{-4} Wb \). [use the B-H curve provided herewith]
Section-A (Answer any THREE questions)

1 (a) Define and provide examples of active and passive circuit elements.
(b) What do you understand by independent and dependent sources? Draw corresponding symbols. Write down the names of different types of dependent sources.
(c) Explain: open circuit and short circuit.
(d) Find currents and voltages shown in the circuit of Fig. 1d.

2 (a) Find the equivalent resistance $R_{eq}$ in the circuit of Fig. 2a with terminals a and b (i) open circuited and (ii) short circuited.
(b) Explain voltage and current divider rule for three resistors.
(c) For the bridge network in the circuit of Fig. 2c, find the equivalent resistance in a-b terminal and total current $i$.

3 (a) What is supernode? Determine the node voltage and currents through each resistor using nodal analysis from the circuit in Fig. 3a.
(b) Use mesh analysis to find $i$ in the circuit of Fig. 3b.
(c) State superposition theorem.

4 (a) State Millman’s theorem and Compensation theorem.
(b) A black box with a circuit in it is connected to a variable resistor as shown in Fig. 4b(i). The ammeter and voltmeter readings are shown in the table of Fig. 4b(ii). Find the Thevenin’s Equivalence of that Black box.
(c) For the similar network, as in question 4(b) with a resistor, $R= 20 \, \Omega$ and a 3 mA current source connected in parallel as shown in Fig. 4c, find the voltage $V$.
(d) Determine the value of external load resistance $R_L$ from Fig. 4d that will result in the maximum power dissipated in that branch if connected with the black box, as in question 4(b). Also determine the maximum load power $P_{\text{max}}$. 

\[ \text{Fig. 1d} \]
\[ \text{Fig. 2a} \]
\[ \text{Fig. 2c} \]
\[ \text{Fig. 3a} \]
\[ \text{Fig. 3b} \]
Section-B (Answer any THREE questions)

5 (a) What do you mean by energy storage passive circuit elements? 
(b) Derive the equation for energy stored in the electromagnetic field of an inductor.
(c) Assuming that the inductors are initially uncharged, find \( v_c(t) \) in the circuit of Fig. 5c.
(d) Determine \( v_c, i_L \) and the energy stored in the capacitor and inductor in the circuit of Fig. 5d under dc conditions.

6 (a) What is magnetomotive force? Define permeability and relative permeability.
(b) Draw the magnetic hysteresis loop of a ferromagnetic material and show the following: saturation magnetization, coercive force and residual flux density.
(c) If a magnetization force \( H \) of 600 At/m is applied to a magnetic circuit, a flux density \( B \) of \( 1200 \times 10^{-4} \) Wb/m \(^2\) is established. Find the permeability \( \mu \) of a material that will produce twice the original flux density for the same magnetizing force. [use the B-H curve provided herewith]
(d) For the rectangular magnetic circuit with two different types of material, find the current necessary to establish a flux of \( \Phi = 2 \times 10^{-4} \) Wb in the section of the core indicated in Fig. 6d. [use the B-H curve provided herewith]

7 (a) State Faraday’s law of electromagnetic induction.
(b) Differentiate among ferromagnetic, diamagnetic, and paramagnetic material.
(c) State and explain Ampere’s circuital law for magnetic circuits.
(d) Determine the current \( I \) required to establish a flux of \( 1.5 \times 10^{-4} \) Wb in the section of the core indicated in Fig. 7d above.

8 (a) What are the general requirements for shunt resistance to be used with a galvanometer in constructing an ammeter?
(b) A 1 mA meter movement having an internal resistance of 50 \( \Omega \) is used to convert a multirange ammeter having ranges 0-10 mA, 0-20 mA and 0-100 mA. Determine the values of the shunt resistance.
(c) Describe the construction of a voltmeter.
Notes:

1. Answer to all parts (a), (b), (c) etc. of a question must be contiguous.
2. Use separate answer script for each section (A/B).
3. Right margin indicates the full marks.

Section A (Answer any THREE questions)

1 (a) What is mainframe computer? Explain the purposes of different units of a computer. 3
(b) Define the terms: machine language, assembly language, and high level language. 2
(c) What is flowchart? Briefly describe different symbols used in a flowchart. 2.75
(d) Differentiate between compiler and interpreter. 1

2 (a) What are the basic data types in C? Explain with examples, how can you modify the basic data types with modifiers. 3
(b) Write down the naming rule of identifier in C. Identify and correct errors, if any, in the following code: 3
   #include<stdio.h>
   void main(int argc[])
   {
   Int var1=10, Float var2,
   var2=var1+4
   printf("%d
", var2);
   }
(c) Where variable are declared in C? Determine and explain the output of the following program fragment: 2.75
   #include<stdio.h>
   int main()
   {
   int val=10, y=10;
   y+=++val;
   val+=y--;
   printf("val=%d, y=%d\n", ++val, y++);
   return 0;
   }

3 (a) What are the loop control statements in C? Explain with an example, how an infinite loop can be created? 3
(b) Differentiate between switch-case and if-else-if statements. What will be the output of the following program: 2
   #include<stdio.h>
   int main()
   {
   int x=5, y=5;
   printf("The square value is: %d \n", ((++x>y++)?x*x:y*y));
   }
(c) Why array is called a homogeneous data structure? Write a C program to read and determine the average of n elements in a single dimensional array, and then print all elements of the array that are larger than the average value. 3.75

4 (a) What is a pointer in C? Explain the necessity of pointer in C. 2
(b) What is library function? How to read and write a character from keyboard? 2.5
(c) What is the difference between call-by-value and call-by-reference? 2
(d) Define union and structure. Write the syntax of structure and union. 2.25

Section B (Answer any THREE questions)

5 (a) Define class and object with suitable example. 1.75
(b) Why C++ is called object oriented programming? 2.5
(c) What is inheritance? Write a program that explains multilevel inheritance. 4.5

6 (a) What are the purposes of constructor function? Explain it with an example, how a copy constructor works? 2.75
(b) What is the wrong of the following fragment?
   class samp{
   int a;
   public:
   samp(int i) { a=i;}
   //................
   };
   int main()
   {
   samp x,y(10);
   //........
   }
(c) Briefly explain what the overload keyword does and why it is no longer needed. 2
(d) Give two reasons why you might want to overload a class's constructor.  

7 (a) Draw and explain the architecture of I/O stream in C++.  
(b) How does Stream I/O Work?  
(c) Write a program in C++ that explain Stream I/O.  

8 (a) What is Exception Handling? In what condition exception occurs.  
(b) Explain the mechanism of Exception Handling.
Section-A (Answer any THREE questions)

1(a) Classify computers according to generations. 3
(b) What is CPU? Briefly discuss the functions of different parts of a CPU. 3
(c) What is algorithm? Write an algorithm to find out the largest of three numbers. 2.75

2(a) What are the basic data types in C? Provide examples. 1
(b) How variable can be declared and used in C? Identify and correct the error, if any, in the following code:
```c
#include "stdio.h"
void main(int argc[])
{
    j =10;
    printf("%d\n" j++);
    return 0;
}
```
(c) Write down the statement of “While”. Write a program that will calculate the average on n numbers by using while statement. 3.75
(d) What is the benefit of the register variable? In which situation it is generally used? 2

3(a) What are the control statements in C? Briefly describe each of them. 3
(b) Differentiate between switch-case and if-else-if statements. 2
(c) What are the purpose of break and continue statements? Write a C program to determine all of the prime numbers in the range 1 to 1000. 3.75

4(a) What is array data structure? Write a C program to read an integer array of n elements and sort the array in ascending order. 3.75
(b) What is string in C? What are the purposes of gets and getchar functions? 2
(c) Determine and explain the output of the following program.
```c
#include <stdio.h>
main()
{
    printf("|%s|\n",Name);
    printf("|%1s|\n",Name);
    printf("|%-10s|\n",Name);
}
```

Section-B (Answer any THREE questions)

5(a) What is a pointer in C? 2
(b) What is library function? How can you read and write a character from keyboard? 2.5
(c) What is the difference between call-by-value and call-by-reference? 2
(d) Explain with an example, how does the recursive function work? 2.25

6(a) What do you mean by dynamic memory allocation? 3
(b) How can you pass argument to main? Explain. 3
(c) Write a program that accepts a string from the user and calculate its length. 2.75

7(a) What is structure? How does Structure differ from array? How can structure variable be declared? 4.5
(b) How is an array of structure initialized? 2.25
(c) Define static variable and pointer to function. 2

8(a) Define union. Explain the syntax of union with suitable example. 4
(b) How does a union differ from a structure? Explain with example. 4.75
Section-A (Answer any THREE questions)

1. (a) Define differential equations (D.E), its order and degree with examples. 3
   (b) Form the D.E of the family of curves \( y = k(x - k)^2 \), \( k \) being an arbitrary constant. 2.75
   (c) What do you mean by linear and non-linear D.E’s? Give their examples. 3

2. (a) Find the necessary and sufficient condition for the exactness of the ODE. 8.75
   (b) Solve \( (x^2 + 1) \frac{dx}{dy} + 4xy = x \). 3
   (c) Define Bernoulli equation. Solve \( \frac{dy}{dx} + xy = xy^3 \). 2.75

3. Solve the following D.E’s
   (a) \( (y + \sqrt{(x^2 + y^2)} dx - xdy = 0 \)
   (b) \( (x^2 + 1) \frac{dy}{dx} + 4xy = x, \quad y(2) = 0; \)
   (c) \( \frac{dy}{dx} + y = xy^3 \). 3

4. (a) Identify and solve \( y''' - 4y'' - 3y' + 18y = 0 \). 3
   (b) Solve \( y = px - p^2 + p \) and obtain the singular solution, where \( p \equiv \frac{dy}{dx} \). 2.75
   (c) Solve \( (D^2 - 2D + 5)y = e^{2x} \sin x \) by operator method. 3

Section-B (Answer any THREE questions)

5. (a) Find the differential equation arising from \( \phi\left(\frac{x}{z}, \frac{y}{z}\right) = 0 \), where \( \phi \) is an arbitrary function of the argument. 3
   (b) Find the general solution of \( y^2z' - x^2y = x^2y \). 2.75
   (c) Find the equation of the surface satisfying \( 4yzp + q + 2y = 0 \) and passing through \( y^2 + z^2 = 1, \quad x + z = 2 \). 3

6. (a) Solve \( z = p^2 + q^2 \). 3
   (b) Find the complete integral of the equation \( px + qy = pq \) by Charpit method. 3
   (c) Solve \( z = pq \). 2.75

7. (a) Solve the equation \( x^2r + 2xys + y^2t = 0 \). 2.75
   (b) The equation of vibrating strings is \( \frac{\partial^2y}{\partial t^2} = \frac{1}{a^2} \frac{\partial^2y}{\partial x^2} \). Show that \( V = F(x - at) + F(x + at) \). 2.75
   (c) Obtain a general solution in series of powers \( x \) of the equation \( x \frac{d^2y}{dx^2} + \frac{dy}{dx} + xy = 0 \). 3.25

8. (a) Define Bessel’s function \( J_n(x) \). Prove that, \( x J'_n = n J_n - x J_{n+1} \). 4
   (b) Define Legendre’s polynomial \( P_n(x) \). Show that, \( P_n(x) = \frac{1}{2^n (n!)} \frac{d^n}{dx^n} (x^2 - 1)^n \). 4.75
Notes:
1. Answer to all parts (a), (b), (c) etc. of a question must be contiguous.
2. Use separate answer script for each section (A/B).
3. Right margin indicates the full marks.

Section-A (Answer any THREE questions)

1. (a) What is the complement of a set $A$? Prove that $(A \cap B)^c = A^c \cup B^c$. 2.75
   
(b) Let $A = [-1, 1]$. Let the functions $f_1, f_2, f_3$ of $A$ be defined by: (i) $f_1(x) = x^2$, (ii) $f_2(x) = x^5$, (iii) $f_3(x) = \sin x$, (iv) $f_4(x) = \sin \frac{5}{2}x$. State whether or not each of these functions has an inverse function. 3
   
(c) Define symmetric and anti-symmetric relations. Let $R$ and $R'$ be symmetric relations in a set $A$. Prove that $R \cap R'$ is a symmetric relation in $A$. 3

2. (a) Show that the equation
   $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} + \cdots + \frac{n^2}{x^n} - k$, has no imaginary roots. 3
   
(b) If $a, b, c$ are the roots of the equation $x^3 - px^2 + qx - r = 0$, find the value of $\sum \left(\frac{b}{a} + \frac{c}{b}\right)$. 2.75
   
(c) Find the condition that the equation $ax^3 + 3bx^2 + 3cx + d = 0$ may have two roots equal. 3

3. (a) Find the condition that $x^3 + 3px^2 + 3qx + r = 0$ is the roots in A.P. 2.75
   
(b) If the equation $ax^3 + bx^2 + cx + d = 0$ has two equal roots, then prove that $(ad - bc)^2 = 4(ac - b^2)(bd - c^2) = 0$. 3
   
(c) Solve the cubic equation $x^3 - 15x^2 - 33x + 847 = 0$ 3

4. (a) If $x + \frac{1}{x} = 2 \cos \theta$, then show that $x^n + \frac{1}{x^n} = 2 \cos n\theta$. 3
   
(b) Expand $\cos^2 \theta$ in powers of $\theta$. 3
   
(c) Find the value of the series $1 - \frac{2}{3!} + \frac{3}{5!} - \frac{4}{7!} + \cdots \to \infty$. 2.75

Section-B (Answer any THREE questions)

5. (a) Show that $\pi = \frac{2}{3} + \frac{1}{5} + \frac{1}{7} + \frac{1}{11} + \frac{1}{13} + \frac{1}{17} + \cdots \cdots \cdots \cdots \cdots$. 3
   
(b) Sum to infinity the series $\cos \theta - \frac{1}{3} \cos 3\theta - \frac{1}{5} \cos 5\theta - \cdots \cdots \cdots$. 3
   
(c) If $\cos^{-1}(u + iv) = \alpha + i\beta$, prove that $\cos^2 \alpha$ and $\cosh^2 \beta$ are the roots of the equation $x^2 - x(1 + u^2 + v^2) + u^2 = 0$. 2.75

6. (a) Find the projection of the vector $4\mathbf{i} - 3\mathbf{j} + \mathbf{k}$ on the line passing through the points $(2,3,-1)$ and $(-2,-4,3)$. 3
   
(b) If $\mathbf{A} = 4\mathbf{i} - 3\mathbf{k}$ and $\mathbf{B} = -2\mathbf{i} + j - 2\mathbf{k}$, find a unit vector perpendicular to both $\mathbf{A}$ and $\mathbf{B}$. 2.75
   
(c) If $\phi(x, y, z) = xy^2z$ and $\mathbf{A} = xz\mathbf{i} - yx^2\mathbf{j} + yz^2\mathbf{k}$, find $\frac{\partial^2}{\partial y^2 z^2}(\phi \mathbf{A})$ at $(3, 1, 3)$. 3

7. (a) Define gradient of a scalar field. Find a unit normal to the surface $x^2y + 2xz = 4$ at the point $(2, -2, 3)$. 2.75
   
(b) Find the angle between the surfaces $x^2 + y^2 + z^2 = 9$ and $z = x^2 + y^2 - 3$ at the point $(2, 1, 2)$. 3
   
(c) If $\mathbf{A} = x^2y\mathbf{i} - 2xz\mathbf{j} + 2yz\mathbf{k}$, find curl curl $\mathbf{A}$. 3

8. (a) Suppose that the surface $S$ has projection $R$ on the xy plane. Show that
   $$\int_S \mathbf{A} \cdot d\mathbf{S} = \int_R \mathbf{A} \cdot \mathbf{n} \ dxdy \ .$$
   
(b) Verify Green’s theorem in the plane for
   $$\oint_C (3x^2 - 8y^3)dx + (4y - 6xy)dy \ ,$$
   where $C$ is the boundary of the region defined by $y = \sqrt{x}, y = x^2$. 4.75
Section-A (Answer any THREE questions)

1 (a) State the postulates of Bohr’s atomic theory. 2.5
(b) Mention the significance of four quantum numbers. Give the values of the quantum numbers associated with the following orbitals: (i) 3d, (ii) 2p and (iii) 4f. 2.75
(c) Calculate the wavelength (in nm) of a photon emitted by a hydrogen atom when its electron drop from the n=4 state to the n=2 state (R_H=1.097×10^{-7}m^{-1}). In what region of the spectrum does this emission occur? 2.5
(d) Write down the electronic configurations of (i) Cu^+(29) and (ii) Cr(24) 1

2 (a) Discuss the classification of elements in the periodic table on the basis of the electronic configuration. 3
(b) Mg^{2+} ion is smaller in size than O^{2-} ion, although both have the same electronic structure why? 2.75
(c) What is meant by electron affinity? Arrange the following elements in order of their increasing electron affinity: F, Na, Cl, K, Br and I. 2
(d) Classify the following elements as metals, non-metals and metalloids: As, Xe, Fe, Si, Cl, Cu, P and Cr. 1

3 (a) Describe a co-ordinate bond with suitable example. How does it differ from a covalent bond? 3
(b) Draw the MO energy level diagram of O_2^+ and O_2^- ions. Find out the bond orders and predict the stabilities of the ions. 3
(c) Mention the shape of the following molecules: (i) NH_3, (ii) SF_6, (iii) BF_3 and (iv) PCl_5. 1
(d) Explain why H_2O boils at much higher temperature than H_2S. 1.75

4 (a) Explain the Arrhenius concepts of acids and bases. What are the limitations of this concept? 2.75
(b) What is Lewis base? Give example. 2
(c) Classify the following as acids and bases with reference to an acid-base concept: (i) BF_3, (ii) CaO, (iii) [Al(H_2O)_6]^{3+} and SO_2. 3
(d) Arrange the following with the increasing order of their acidity HClO, HClO_2, HClO_3, HClO_4. 1

Section-B (Answer any THREE questions)

5 (a) Explain the terms molarity, molality and mole fraction of a solution. 2.75
(b) State and explain Raoult’s law of lowering of vapor pressure. Establish the relationship between elevation of boiling point and lowering of vapor pressure. 1+2
(c) What is meant by osmosis? State van’t Hoff law of osmotic pressure and deduce osmotic pressure equation. 1+2

6 (a) Explain the terms phase, component and degrees of freedom. 2.75
(b) A saturated solution of NaCl with excess of salt is at equilibrium with its vapour in a closed vessel. How many phases, components and degrees of freedom are there in the system? 2
(c) Draw and explain the phase diagram of one component three phase system. The triple point of this system is invariant-Explain. 3+1

7 (a) Define and explain the terms rate, order and molecularity of a reaction. 2.75
(b) Derive mathematical expression for the rate constant of a second order reaction (A+B→Products) having identical initial concentration of the reactants. Show that the half-life of such reaction is inversely proportional to the initial concentration of the reactants. 2+1
(c) Write down Arrhenius equation for rate constant and define the terms therein. Explain the principle for determination of activation energy. 1.5+1.5

8 (a) What are strong and weak electrolytes? What is a buffer solution? Give examples. 2.75
(b) Explain the mechanism of electrolysis with appropriate figure. What is meant by electrochemical equivalent? 2+1
(c) Define specific conductance and equivalence conductance. Show the relationship between them. Explain the change in equivalent conductance of strong and weak electrolytes with dilution. 2+1
Section-A (Answer any THREE questions)

1 (a) What are electrolytes? What is the modern concept about strong electrolytes? Explain why the equivalent conductance of a solution of a strong electrolyte gradually increases with dilution.

(b) State and explain the principle of independent ionic migration.

(c) Explain the conductometric behavior of a system where a strong acid is titrated with a strong base.

2 (a) Explain chemical equilibrium with appropriate figure. Mention five characteristics of chemical equilibrium. Why chemical equilibrium is called a dynamic equilibrium?

(b) Describe briefly the various factors which influence the equilibrium constant of a reaction.

(c) Discuss the application of Le Chatelier’s principle to the following reactions:
   (i) $2HI \rightleftharpoons H_2 + I_2$ \[ \Delta H = -51.8 \text{ kJ} \]
   (ii) $A + B \rightleftharpoons C$ \[ \Delta H > 0 \]

3 (a) What is meant by order of a reaction? Derive integrated rate equation for first order reaction and show that the half-life of a first order reaction is independent of the initial concentration of the reactant.

(b) Define temperature coefficient of a reaction. Write down Arrhenius equation for rate constant and define the terms therein.

(c) Define the terms: (i) catalyst and (ii) inhibitor.

4 (a) Distinguish between physical adsorption and chemical adsorption (chemisorption). Discuss how physical adsorption may pass on to chemisorption in the same system on changing the temperature.

(b) Define the term ‘colloids’. How do colloidal particles gain stability?

(c) Define the term coagulation. Explain Hardy-Schulze rule for coagulation.

Section-B (Answer any THREE questions)

5 (a) Write down the postulates of Bohr’s atomic model.

(b) What are quantum numbers? State and explain the Pauli exclusion principle.

(c) How many subshells are possible in third energy shell? What is the maximum number of electrons that can occupy a d subshell?

6 (a) What is periodic law? Discuss the classification of the elements on the basis of electronic configuration of their atoms.

(b) Define electron affinity. Explain why the electron affinity of F-atom is higher than that of Cl-atom.

(c) What is covalent bond? Illustrate with example.

7 (a) Distinguish between the properties of ionic and covalent compounds.

(b) What is hydrogen bond? Define different type of hydrogen bond with examples.

(c) Draw the molecular orbital energy level diagram for O_2 molecule and explain why it is paramagnetic. Find out its bond order.

8 (a) What are lanthanides? Discuss their position in the periodic table.

(b) What are transition metals? Write the ground state electronic configuration of the following metals/ions: Cr(24), Cu(29), Mn^{2+}(25), Ni^{2+}(28).

(c) Explain the following (any two):
   (i) Most of the transition metal ions form colored compounds;
   (ii) Fe^{3+} is more stable than Fe^{2+};
   (iii) NaCl is soluble in water, but insoluble in CCl_4.
Section-A (Answer any TWO questions)

1 (a) What is linking verb? Define complex and compound sentences with examples. 2.75
(b) Complete the following sentences with words/phrases/clauses:
   i. The girl ……………. on the stage is my sister.
   ii. The rumor ……………. is not true.
   iii. I would have travelled around the world ……………
   iv. ……………. the boy is praised by all.
   v. He works hard ……………
   vi. We reached the station ……………
(c) Convert the words as directed and make meaningful sentences with the converted forms:
   i. achieve (adjective) ii. depth (verb) iii. large (noun) iv. poor (verb) v. west (adverb)
   vi. assure (adjective)

2 (a) Define clause with an example. 0.75
(b) Give meaning and make sentences with the following idioms and phrases:
   i. as to ii. every other day iii. on and on iv. ere long v. sine die vi. in black and white
(c) Analyze the structure of the following sentences:
   i. Many students were expelled
   ii. She wrote me a letter.
   iii. They are too poor to make both ends meet.
   iv. You may leave now.
   v. If I were rich, I would buy a car.

3 (a) Define diphthong. 0.75
(b) Transform the following sentences as directed:
   i. Mr. Smith was too weak to walk. (change it into compound)
   ii. Dhaka is the largest city in Bangladesh. (change it into positive)
   iii. Close the windows. (change it into polite request)
(c) Respond to the following questions:
   i. For what purpose do we use language?
   ii. Do you fit well in the tight semester schedule?
   iii. Why Rajshahi is called the “Silk City”?
   iv. What do you feel about your foreigner friends?
   v. Write about your first impression of Rajshahi University and your department.

Section-B (Answer any TWO questions)

4. Read the passage carefully and answer the questions that follow:
   Cybercrime, or computer related crime, is crime that involves a computer and a network. The computer may have been used in the commission of a crime, or it may be the target. Debarati Halder and K. Jaishankar define cybercrimes as: “Offences that are committed against individuals or groups of individuals with criminal motive to intentionally harm the reputation of the victim or cause physical or mental harm, or loss, to the victim directly or indirectly, using modern telecommunication networks such as internet (networks including but not limited to Chat rooms, emails, notice boards and groups) and mobile phones (Bluetooth/SMS/MMS)”. Cybercrime may threaten a person or nation’s security and financial health. Issues surrounding these types of crimes have become high-profile, particularly those surrounding hacking, copyright infringement, unwarranted mass-surveillance, child pornography, and child grooming. There are also problems of privacy when confidential information is intercepted or disclosed, lawfully or otherwise. Debarati Halder and K. Jaishankar further define cybercrime from the perspective of gender and defined ‘cybercrime against women’ as “Crimes targeted against women with a motive to intentionally harm the victim psychologically and physically, using modern telecommunication networks such as internet and mobile phones”. Internationally, both governmental and non-state actors engage in cybercrimes, including espionage, financial theft, and other cross-border crimes.
(a) What is cybercrime? 2
(b) How does cybercrime affect individual lives? 2
(c) Describe how cybercrime destroys the concept of privacy. 2
(d) Do you think that women fall victims to cybercrime? 2
(e) Define surveillance. 0.75

5 (a) Write a paragraph on any One of the following: 5
   i.  Women Politics in Bangladesh
   ii. Science versus Nature
   iii. Engineering in Everyday Life
(b) Write a memo as the Chief Executive Officer of Grameen Phone Company to all the employees informing them that they are going to receive a year-end bonus. 3.75

6 (a) Write an application to the Registrar, North South University, for the post of Senior Lecturer in the department of Electrical and Electronic Engineering. 4
(b) Write a letter to the editor of a daily newspaper commenting on the campus violence and its impact on university education. 4.75