Time: 3 hrs. **M. M.: 100**

N.B.:

1. **All** questions are **compulsory**.
2. **Figures** to the **right** indicate **full** marks.
3. Draw **neat** diagrams wherever **necessary**.
4. Symbols have usual meaning unless otherwise stated.
5. Use of **non-programmable** calculator is allowed.

Q1. Attempt any **two**

(i) Describe the construction of SCR. With the help of equivalent circuit and I-V characteristics, explain the working of SCR. **10**

(ii) Explain the voltage divider bias of a JFET. State and explain the condition under which the drain current in voltage divider bias is approximately constant for any JFET. **10**

(iii) Explain the construction and working principle of a Unijunction Transistor (UJT). Draw and Explain I-V characteristics of UJT. Explain peak point and valley point. **10**

(iv) Explain the construction and working of n-channel D-MOSFET. Draw and discuss its drain and trans-conductance curves. **10**

Q2 Attempt any **two**

(i) Explain with the help of neat circuit diagram, the DC analysis of an emitter coupled differential amplifier with double ended input Configuration and single ended output. Derive the necessary expressions. **10**

(ii) With the help of a neat circuit diagram and relevant waveforms, explain the working of triangular wave generator using Schmitt trigger and integrator. What is the expression for frequency and peak to peak voltage of the triangular wave? **10**

(iii) Explain with neat circuit diagram the working of the emitter coupled differential amplifier with double ended input and double ended output. **10**

(iv) Explain in detail the construction and working of logarithmic amplifier. Obtain an expression for its output voltage varies as the logarithmic of the input. **10**

Q3 Attempt any **two**

(i) Explain with the help neat circuit diagram and relevant waveforms transistorized Astable multivibrator. **10**

(ii) Explain with the help of neat circuit diagram and relevant waveforms Monostable multivibrator using IC 555 timer. Derive an expression for output pulse width. **10**

(iii) Explain with the help of neat circuit diagram and relevant waveforms ramp generator using IC 555 timer. Derive an expression for the slope of the ramp. **10**

(iv) Explain with the help neat circuit diagram working of a transistor series voltage feedback regulator. Derive an expression for its output voltage and power dissipation. **10**

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Q4 Attempt any **two**

(i) With the help of a neat circuit diagram explain the working of two input TTL NOR gate. Draw its truth table. **10**

(ii) Explain the working of a tri state inverter. **10**

(iii) Explain parallel transmission of data. Explain a technique that converts parallel transfer of data to serial transfer of data and vice versa. **10**

(iv) Explain Pulse Modulation. Explain in detail companding process used to overcome problems of distortion and noise in the transmission of audio signals. **10**

Q5. Attempt any **four**

(i) For a certain D-MOSFET, I_{DSS} = 10 mA, $V_{GS(OFF)}$ = -8 V. is this an n-channel or p-channel?. Calculate (i) I_D at V_{GS} = -3V and (ii) I_D at V_{GS} = +3V **05**

(ii) The parameters of UJT are R_{BB} = 5 $k\Omega$ and $\eta = 0.6$ (i) Determine R_{B1} and R_{B2} at I_E = 0 (ii) Calculate the voltage V_P necessary to turn on the UJT if supply voltage is 12 V. **05**

(iii) In differential amplifier circuit of double ended input and single output, V_{CC} = + 12 V, V_{EE} = - 12 V, R_C = 10 KΩ and $V_1 = V_2$ = 0V. What is the dc emitter current in each silicon transistor? What is the tail current? What is the dc voltage at output? **05**

(iv) First order active low pass filter has C = 0.1μF and R= 1kΩ . Calculate cut-off frequency. If R_F is 1kΩ and R_i is 1kΩ, Calculate pass band gain. **05**

(v) A pulse of 2 μs duration is used to trigger the transistorized monostable circuit, If $R_{L1} = R_{L2}$ = 3 kΩ , R_1 = 80 kΩ and C_1 = 0.001 μF. calculate the length of the output pulse **05**

(vi) Calculate the frequency of oscillation and duty cycle for 555 timer as astable multivibrator with resistance $R_A = R_B$ = 10 kΩ and capacitance 0.01 μ F. **05**

(vii) Data sheets for 74COO series devices give the following output currents for CMOS driving CMOS: I_{OLmax} = l0 μA I_{OHmax} = -10 μA. If the worst case input current of a CMOS device is 1 μA, calculate its fanout. **05**

(viii) Explain pulse width modulation (PWM) in brief. **05**

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[Time: 03 Hours.] **[Marks: 100]**

Please check whether you have got the right question paper.

N.B: 1. All questions are compulsory and carry equal marks.
2. Figures to the right indicate full marks.
3. Draw neat and labelled diagrams wherever necessary.
4. Answer the questions in proper order.

Q. 1 Describe Any Two of the following: **(20)**
a) Energy resources
b) Water (Prevention and Control of Pollution) Act, 1974.
c) Rainwater harvesting

Q. 2 Explain Any Two of the following: **(20)**
a) Describe types of trees harvesting.
b) Techniques involved in wildlife census.
c) Describe types of habitat and territories.

Q. 3 Give an account on Any Two of the following: **(20)**
a) Economic value of Bioprospecting
b) Methods of self-medication through geophagy
c) Applications of Zoopharmacognosy

Q. 4 Describe Any Two of the following: **(20)**
a) Isolating mechanisms
b) Patterns of animal distribution
c) Zoogeography of Ethiopian realm

Q. 5 Write short notes on: (Any Four) **(20)**
a) Solar energy.
b) e-waste management
c) Capture mark recapture method
d) Modern bioprospecting
e) Contribution of Zoopharmacognosy to human medicines
f) Fauna of Australian region

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Time: 3 hrs. **M. M.: 100**

N.B.:

1. **All** questions are **compulsory**.
2. **Figures** to the **right** indicate **full** marks.
3. Draw **neat** diagrams wherever **necessary**.
4. Symbols have usual meaning unless otherwise stated.
5. Use of **non-programmable** calculator is allowed.

Q1. Attempt any **two**

(i) State Kepler's three laws of planetary motion and prove second and third laws. **10**

(ii) Show that when body moves in a central force field its motion is confined to a plane. **10**

(iii) Obtain the equation of motion of a particle of mass m as related to the rotating earth. **10**

(iv) A starred system rotates with a variable angular velocity ω with respect to inertial system fixed in space. Show that $\frac{d\mathbf{r}}{dt} = \frac{d^*\mathbf{r}}{dt} + \boldsymbol{\omega} \times \mathbf{r}$ Hence obtain the Coriolis theorem. **10**

Q2 Attempt any **two**

(i) a) What is virtual displacement? **10**
b) State and derive an expression for the principle of virtual work.

(ii) a) Define the generalized force Q_k. Using that definition, show that, **10**

$$Q_k = -\frac{\partial V}{\partial q_k}$$

Where V is potential and q_k are generalized coordinates.

b) Show that, for Cartesian coordinates x_i and general coordinates q_k,

$$\frac{\partial \dot{x}_i}{\partial \dot{q}_k} = \frac{\partial x_i}{\partial q_k}$$

(iii) Consider a particle constrained to move on the inner surface of the cone with half angle α. Set up the Lagrangian and get the equations of motion. **10**

(iv) a. What is canonical momentum? For a Lagrangian given by **10**

$$L = \frac{1}{2}m(\dot{x}^2 + \dot{y}^2 + \dot{z}^2) - q\phi(x, y, z) + q\left(\vec{A} \cdot \vec{v}\right)$$

b. Calculate all the components of canonical momentum.

c. Is this canonical momentum a conserved quantity? Give reason to your answer.

Q3 Attempt any **two**

(i) Derive Euler's equation of motion for a rigid body .Discuss its cases for spin, moment of inertia and angular velocity is at constant ,zero and nonzero **10**

(ii) Obtain an equation of continuity in kinematics of moving fluid .Write the equation if the fluid is incompressible **10**

(iii) Derive Bernoulli's theorem from conservation of linear momentum and energy. Write the meaning of every term in its equation **10**

(iv) What is an Ideal fluid. Obtain the Eulers equation equation of motion for an ideal fluid. state the assumptions **10**

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Q4 Attempt any **two**

(i) What is an Anharmonic oscillator? Write down the general expression for restoring force indicating harmonic and anharmonic terms.Draw potential energy curves for (i) $\propto < 0$, $K > 0$ (ii) $\propto < 0$, $K < 0$. Infer on the confined motion in each case, If potential energy of Anharmonic oscillator is V(x) = K ($\frac{x^2}{2} + \frac{\propto x^4}{2}$). Where K→ $spring\ constant$, $\alpha \rightarrow anharmonic\ coefficient$. **10**

(ii) What is logistic map? Find its fixed points, showthat the fixed point x=0 is an attractor for $\Lambda < 1$ and a repeller for $\Lambda > 1$. **10**

(iii) Obtain reduced Duffing's equation by suitable rescalling. Discuss numerical solutions of Duffing's equation for γ =0.1, f = 0.5 graphically showing odd and even harmonics. Explain the mechanical hysteresis. **10**

(iv) Show that the undamped duffing's equation $\ddot{x}$ +x+x^3 =f coswt can have the exact solution x(t)=A_0 cos$\frac{wt}{3}$. find the conditions under which such simple subharmonic solution occurs. **10**

Q5. Attempt any **four**

(i) Define central force. Explain types of central forces. **05**

(ii) Interpret the various terms involved in the Coriolis's theorem **05**

(iii) Set up the Lagrangian for a simple pendulum. Using that derive the equation of motion. **05**

(iv) Define constraints. Give three examples **05**

(v) Consider a liquid flowing through horizontal tube of non-uniform cross-section. The pressure is 1600 N/m^2 at a point where the velocity of flow is 0.5 N/m^2 what is the Velocity of flow at a point where pressure is 1000 N/m^2 .Density of liquid is uniform and is equal to 1000 kg/m^3 . **05**

(vi) A rigid body consists of three particles of masses 2, 1 and 4 units located at (1, −1,1), (2,0,2) and (−1,1,0) respectively. Determine the elements of the moment of inertia matrix for the rigid body. **05**

(vii) Write down three properties of deterministic chaos **05**

(viii) What is phase space diagram? Plot phase space diagram for one - dimentional damped oscillator and driven oscillator. **05**

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[Time: 3 Hours.] **[Marks: 100]**

Please check whether you have got the right question paper.

N.B: 1. All questions are compulsory and carry equal marks.
2. Figures to the right indicate full marks.
3. Draw neat and labelled diagrams wherever necessary.
4. Answer the questions in proper order.

Q. 1 Describe Any Two of the following: **(20)**
a) Regulatory protein domain
b) Excision repair of DNA
c) Huntington disease

Q. 2 Describe any two of the following: **(20)**
a) cDNA library.
b) Plasmid vector.
c) Polymerase chain reaction.

Q. 3 Give an account on any two of the following: **(20)**
a) Non-disjunction of autosomes
b) Cystic fibrosis
c) Breast cancer

Q. 4 Describe any two of the following: **(20)**
a) Biological databases
b) UniProt
c) FASTA

Q. 5 Write short notes on: (any four) **(20)**
a) Nonsense mutations
b) DNA sequencing by chain termination method
c) Amniocentesis
d) PubMed
e) Hydroxylating agent mediated mutation
f) PROSITE

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[Time: 3 Hours] **[Marks: 100]**

Please check whether you have got the right question paper.

N.B: 1. All questions are compulsory and carry equal marks.
2. Figures to the right indicate full marks.
3. Draw neat and labelled diagrams wherever necessary.
4. Answer the questions in proper order.

Q. 1 Describe Any Two of the following: **(20)**

a) Factors affecting enzyme activity.
b) Enzyme inhibition with reference to competitive inhibitor and its kinetics.
c) Classification of enzymes based on Enzyme Commission.

Q. 2 Explain Any Two of the following: **(20)**

a) Acclimation and Acclimatization.
b) Osmotic and ionic regulation in hyperosmotic environment.
c) Aestivation and Hibernation.

Q. 3 Give an account on Any Two of the following: **(20)**

a) Histological structure of Pancreas and its hormones.
b) Mechanisms of hormone action.
c) Histological structure and disorders of Adrenal gland.

Q. 4 Describe Any Two of the following: **(20)**

a) Advantages and limitations of animal tissue culture
b) Media used for culture.
c) Basic principles of sterilization techniques.

Q. 5 Write short notes on: (Any Four) **(20)**

a) Lactate dehydrogenase.
b) Circadian rhythm.
c) T.S. of Thyroid gland.
d) Importance of sterility in cell culture.
e) Role of kidney in ionic regulation.
f) Hormones of neurohypophysis.

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Time: 3 hrs. M. M.: 100

N.B.:

1. **All** questions are **compulsory**.
2. **Figures** to the **right** indicate **full** marks.
3. Draw **neat** diagrams wherever **necessary**.
4. Symbols have usual meaning unless otherwise stated.
5. Use of **non-programmable** calculator is allowed.

Constants: Velocity of Light: $c = 3 \times 10^8$ meter per second
Planck's Constants: $h = 6.63 \times 10^{-34}$ joule second

Q1. Attempt any **two**

(i) Explain the invariance of physical law. Obtain the Galilean transformation for velocity and acceleration and hence shows that force remain invariant under Galilean transformation. **10**

(ii) Explain the length contraction hypothesis. Derive necessary equation. Obtain the volume of cube, when moving with velocity V along one of its edges is parallel to X-axis. The proper length of each edge of cube is l_0. **10**

(iii) Derive the inverse Lorentz transformation equations. **10**

(iv) Using Lorentz transformation equations of space time show that space difference in one frame converted to time difference in another frame and time difference in one frame is converted to space difference. **10**

Q2 Attempt any **two**

(i) Derive Lorentz transformation equations for velocity. Using it show that the velocity of light remains the same in all inertial frames of reference. **10**

(ii) With the help of Minkowski space time diagram explain Relativity of simultaneity and length contraction. **10**

(iii) Derive the relativistic aberration formula using the Lorentz transformation of velocity. **10**

(iv) Derive Lorentz transformation equations for components of acceleration. **10**

Q3 Attempt any **two**

(i) Show that the mass of a particle moving with a speed u is to be defined by $m = \frac{m_o}{\sqrt{1-\frac{u^2}{c^2}}}$ **10**

(ii) Show that, in a region in which there is a uniform magnetic field, a charged particle entering at right angles to the field movies in a circle whose radius is proportional to the particle's momentum. Hence compute the radius, both classically and relativistically, of a 10 MeV electron moving at right angles to a uniform magnetic field of 2 Wb/m^2. **10**

(iii) Using relativistic definition of energy and momentum show that **10**

a) $E^2 = p^2c^2 + m_o^2c^4$

b) $u = \frac{dE}{dp}$

(iv) Obtain the Lorentz transformations of momentum and energy. **10**

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Q4 Attempt any **two**

(i) Show that the electric field of uniformly moving point charge in an inertial frame of reference loses its spherical symmetry. **10**

(ii) Derive the expression for force and fields near a current carrying wire. **10**

(iii) Derive the transformation equation for electric field $\vec{E}$ using Lorentz transformation equation for force. **10**

(iv) Show that the Maxwell's equations of electrodynamics are invariant under Lorentz transformation. **10**

Q5. Attempt any **four**

(i) The area of disc in its rest frame is $1m^2$. The disc appears distorted to an observer moving with speed 0.8 c with respect to rest frame along the plane of disc. Find the area measured by an observer. **05**

(ii) Two events separated by spatial distance of $9 \times 10^9 m$ are simultaneous in one inertial frame. What will be the time interval between these two events in another frame moving with velocity 0.8c. **05**

(iii) Write a short note on Twin paradox. **05**

(iv) A source of light of wavelength 6000 AU is approaching an observer with a speed of 0.8c. Find the wavelength of light as observed by the stationary observer. **05**

(v) The earth receives the radiant energy from the sun at the rate of $1.34 \times 10^3\ watts/m^2$. At what rate is the sun losing rest mass due to its radiation? The sun's rest mass is now about $2 \times 10^{30} Kg$. **05**

(vi) Find the mass and kinetic energy of photon of wavelength 5000Å. Take Planck's constant $h = 6.63 \times 10^{34}\ Js$. **05**

(vii) State the postulates of General theory of relativity and explain principle of equivalence **05**

(viii) Obtain the expressions for ρ and $\vec{j}$ in terms of ρ_0. Hence show that $\rho = \left(\frac{\rho_0}{m_0}\right) m;\ \vec{j} = \left(\frac{\rho_0}{m_0}\right) \vec{p}$ **05**

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Duration:[2½Hours] **[Total Marks: 75]**

N.B. 1) All questions are compulsory.
2) Figures to the right indicate full marks.

1. (a) Attempt any **ONE** question:
   i. If $\pi_k(G)$ denotes the chromatic polynomial of a (p, q) graph G then prove that (8)
   (I) The coefficient of k^p in $\pi_k(G)$ is 1.
   (II)The constant term of $\pi_k(G)$ is zero.
   (III) The terms of $\pi_k(G)$ are alternate in sign.
   (IV) The coefficient of k^{p-1} is $-q$ where q is number of edges of G.
   ii. Prove that a graph G with $p \geq 2$ is 2-connected if and only if any two vertices are connected by at least two internally disjoint paths. (8)

   (b) Attempt any **TWO** questions:
   i. If G is graph of order p and $\delta(G) \geq p-2$ then prove that $\kappa(G) = \delta(G)$ where $\kappa(G)$ is vertex connectivity of G and $\delta(G)$ is minimum degree of graph G. (6)
   ii. If G is $k-$ critical graph then show that $\delta(G) \geq k-1$. Hence prove that every $k-$ chromatic graph has at least k vertices of degree at least $k-1$. (6)
   iii. Prove that every tree with $n \geq 2$ vertices is 2-chromatic. (6)

2. (a) Attempt any **ONE** question:
   i. Show that every planar graph is 5 vertex colorable. (8)
   ii. In any Network, show that the value of maximum flow is equal to the capacity of minimum cut. (8)

   (b) Attempt any **TWO** questions:
   i. If G is a planar (p, q) graph in which every face is bounded by a cycle of length at least n then show that $q \leq \frac{n(p-2)}{n-2}$. (6)
   ii. For a plane graph G, prove that G is bipartite if and only if every face of G has even length. (6)
   iii. If G be a simple connected graph with at least 11 vertices then prove that either G or its complement $\overline{G}$ must be nonplanar. (6)

3. (a) Attempt any **ONE** question:
   i. Derive the recurrence relation for the number of regions into which the plane is divided by n straight lines, no two of which are parallel and no three of which are concurrent. Furthermore using generating function, show that the solution of the above recurrence is $\frac{n(n+1)}{2} + 1$. (8)
   ii. Let $\{A_1, A_2, ...A_n\}$ be a family subset of finite set Y. Let $0 \leq t \leq n$. Prove that there exists a subfamily of t sets of A that has an system of distinct representatives if and only if $|A_{i_1} \cup A_{i_2} \cup \cdots \cup A_{i_k}| \geq k-(n-t)$, $\forall k \geq n-t$ and $\forall 1 \leq i_1 < i_2 < ... < i_k \leq n$. (8)

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(b) Attempt any **TWO** questions:

i. Show that the number of nonnegative integer solutions of the equation $x_1 + x_2 + \cdots + x_k = r$ is given by $\begin{pmatrix} r+k-1 \\ r \end{pmatrix}$. (6)

ii. Prove that if B is a board of darkened squares that decomposes into the two disjoint sub boards B_1 and B_2 then prove that $R(x, B) = R(x, B_1)R(x, B_2)$, where $R(x, B)$ is a rook polynomial for board B. (6)

iii. Let h_n denote the number of nonnegative integral solutions of the equation (6)

$$3e_1 + 4e_2 + 2e_3 + 5e_4 = n$$

Find the generating function $f(x)$ for $h_0, h_1, \ldots, h_n, \ldots$

4. Attempt any **THREE** questions:

(a) Show that $\chi'(G) \geq \Delta(G)$ where $\chi'(G)$ denotes edge chromatic number and $\Delta(G)$ denotes the maximum degree of G. Give an example of the graph for which $\chi'(G) = \Delta(G)$. (5)

(b) If G is a cycle on n vertices then show that $\pi_k(G) = (k-1)^n + (-1)^n(k-1)$ where $\pi_k(G)$ is chromatic polynomial of G. (5)

(c) If f is any flow and K be any cut in a network N then show that $val(f) \leq cap(K)$. (5)

(d) If G is planar graph with n vertices, m edges , f regions and k components then prove that $n - m + f = k + 1$. (5)

(e) Let $\{A_1, A_2, ...A_n\}$ be a family of sets such that for each k, $1 \leq k \leq n$ and for each choice of $1 \leq i_1 < i_2 < ... < i_k \leq n$, $|A_{i_1} \cup A_{i_2} \cup \cdots \cup A_{i_k}| \geq k + 1$. Let x be any element of A_1. Show that $\{A_1, A_2, ...A_n\}$ has a system of distinct representatives in which x represents A_1. (5)

(f) Find a recurrence relation for the ways to distribute n identical balls into k distinct boxes with between two and four balls in each box. Repeat the problem with balls of three colors. (5)

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(Time: 3 hours) **Total Marks: 100**

N.B.: (1) All questions are compulsory.
(2) Figures to the right indicate full marks.
(3) Use of log table/ non-programmable calculator is allowed.

Q.1 **Attempt any four of the following.** **20**

A) (a) What is a polarogram? Draw a polarogram and label all the different regions.
(b) Explain- half wave potential and its significance.

B) Explain the construction and working of dropping mercury electrode with a neat labelled diagram.

C) Explain the term polarographic maxima with a neat diagram. How is it eliminated?

D) A 5×10^{-4} M solution of Ba^{2+} ion in 0.1 M KCl as a supporting electrolyte gave a diffusion current of 4.1 μA . If the rate of flow of mercury drops and the drop time is 1.5 mgs^{-1} and 3 second respectively. Calculate diffusion coefficient of Ba^{2+} ion.

E) Explain the nature of amperometric titration curves when,
i) titrant is reducible but other species are not.
ii) both titrant and titrand are reducible

F) Draw a labelled diagram of rotating platinum electrode.
Give the advantages and limitations of amperometric titrations.

Q.2 **Attempt any four of the following.** **20**

A) Explain the following terms: i) retention time ii) retention volume

B) Draw a neat and labelled schematic diagram of gas-liquid chromatography. Give any three requirements of carrier gas.

C) Name the detectors used in gas chromatography. Explain any one detector with the help of a labelled diagram.

D) What are ion exchange resins? What are the requirements of a good ion exchange resin?

E) If the two separated components A and B have retention times 4.45 min. and 6.36 min. respectively. If the peak widths at half peak heights of A and B are 0.22 min. and 0.33 min. respectively. Calculate the number of theoretical plates for each peak.

F) With reference to ion exchange chromatography explain the following applications-
1) Demineralisation of water
2) Separation of Amino acids

Q.3. **Attempt any four of the following.** **20**

A) Explain the physical method of food preservation with reference to
(i)Pasteurisation
(ii) Irradiation

B) Give the composition of milk. Discuss the nutritive value of milk.

C) Explain the Lowenthal's method to estimate tannin in tea.

D) Give the composition of Coffee. What is the role of chicory in Coffee?

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E) Give the constituents of Face Powder. What are the characteristics of Face Powder?

F) What are cosmetics? Give the differences between deodorant and antiperspirant.

Q.4 **Attempt any four of the following.** **20**

A) Give the applications of thermogravimetry.

B) Draw a neat and labelled diagram of thermobalance. Discuss any three components of it.

C) Explain the principle of DTA. Discuss DTA curve of $CaC_2O_4.H_2O$ with respect to curve, reactions and decomposition temperature.

D) Give the characteristics of reference material used in DTA. Mentioned name of any four reference materials used in DTA.

E) Define thermometric titration. Discuss the thermometric titration for Complexometric titration in determination of Calcium and Magnesium

F) Discuss any five parameters used in method validation process.

Q.5 **A)** **Select the correct option and complete the following statements: (any five)** **05**

a) The electrode which has its own potential and cannot take up potential applied on it is called **_____.**
i) dropping mercury electrode ii) non-polarizable electrode iii) rotating platinum electrode

b) In polarography, KCl is used to **_____.** migration current.
i) Eliminat ii) increases iii) maintain

c) The potential at the point on the polarography wave where $i = i_d/2$, is termed as**_____.**
i) Half wave current ii) Half wave potential
iii) decomposition potential

d) **_____.** is directly proportional to the concentration of metal ion.
i) Diffusion current ii) Residual current
iii) limiting current

e) **_____.** is used as maxima suppressor in polarography.
i) KCl ii) Gelatin iii) Pool of mercury

f) Rotating platinum is used in amperometric titration as **_____.** electrode
i) reference ii) working iii) combined

g) In amperometric titration of Zn^{2+} determined by titrating with**_____.**
i) dimethyl glyoxime ii) silver nitrate iii) EDTA

h) When titrand is reducible but titrant and product are not in amperometric titration shows **_____.**
i) constant current till the equivalence point, then increases.
ii) decrease in current till the equivalence point, then constant
iii) increase in current till the equivalence point, then decreases

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Q.5 B) State whether true or false: (any five) **05**

a) Separation of components in gas-liquid chromatography occurs by differential adsorption.
b) The choice of the detector does not depend on the carrier gas.
c) The smaller the magnitude of plate height, the higher is the efficiency of the column.
d) The response of the detector in gas chromatography should be linear.
e) An anion exchanger contains a carboxylic functional group.
f) Styrene on polymerization produces linear polymers.
g) The unit of ion exchange capacity is milliequivalent/gm

Q.5 C) Fill in the blanks with correct alternatives given in the bracket: (any five) **05**

(glucose oxidase, 63°C and 72°C, Lipstick, magnesium silicate, quality, deodorant, methylene blue, irradiation)

a) Food processing improves the _____ value of food.
b) Raw honey contains the enzyme _____
c) _____ prevents/controls body odour.
d) _____ is a physical method of food preservation.
e) Pasteurization of milk is carried out at _____
f) For determination of reducing sugars in honey, by Cole's ferricyanide method _____ is used as an internal indicator.
g) _____ mainly consists of an oily base material and colouring agent
h) Chemically talc is _____.

Q.5 D) Match the columns: (any five) **05**

	A	**B**
i)	Thermometric titration	(a) ΔT plotted against sample temperature
ii)	Thermogravimetric analysis	(b) Closeness of obtained value to true value
iii)	Double pan used	(c) Reference standard
iv)	Accuracy	(d) Exotherm
v)	DTA curve	(e) Weight change measurements
vi)	MgO	(f) Adiabatic condition
vii)	Air oxidation	(g) DTA

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[Time: 3 Hours] **[Marks: 100]**

1. **All questions are compulsory.**
2. **All questions carry equal marks.**
3. **Figures to the right indicate full marks.**
4. **Use of log table/ non-programmable calculator is allowed.**

Q.1 **Attempt any four of the following.** **20**

A) Explain with mechanism the addition of bromine to but-2-ene is both stereospecific and stereoselective reaction? **5**

B) A chiral alcohol reacts with thionyl chloride. Write the reaction and its mechanism. Explain the stereochemistry involved in it. **5**

C) Explain the stereochemistry of $KMnO_4$ oxidation of maleic acid and fumaric acid. **5**

D) Define Topicity. Explain the following with one example: **5**
i. Enantiotopic ligands
ii. Diastereotopic ligands

E) **a)** Explain isolectric point with respect to α-amino acids. **3**

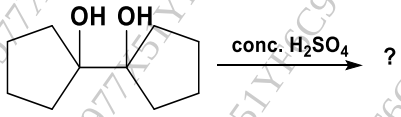
b) Give preparation of alanine by Strecker synthesis. **2**

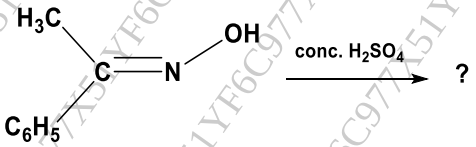
F) Explain in detail the preparation of a tripeptide by using the Merrifield solid phase peptide synthesis? **5**

Q.2 **Attempt any four of the following.** **20**

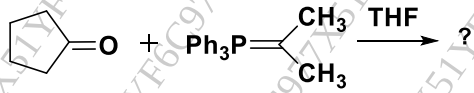
A) What is Favorskii rearrangement? Explain with suitable example. **5**

B) **a)** Complete the following reactions. Give the name of reactions. **3**

i) 

ii) 

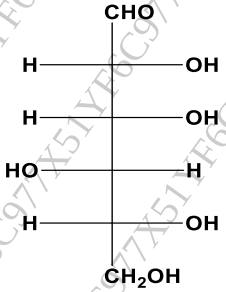
b) Complete the reaction. **2**

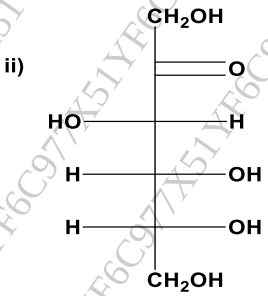


C) **a)** Explain reducing and non-reducing sugars with suitable examples. **3**

b) Write appropriate reactions for acetylation of ∝–D-glucopyranose. **2**

D) Convert the following Fischer projection formula to Haworth formulae. **5**
(β -furanose forms)

i) 

ii) 

E) **a)** Write the reactions for complete methylation of ∝ -D- glucofuranose in a stepwise manner. **3**

b) Draw chair conformations of ∝ and β forms of D-glucopyranose. **2**

F) **a)** How will you convert D-Glucose into D-Arabinose **3**

b) Write the reactions for oxidation of D-glucose using: **2**
i) Bromine water ii) Conc: HNO_3

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Q.3. Attempt any four of the following. **20**

A) Explain how IR spectrum is used to determine the following: **5**
1. If the given compound is aromatic.
2. The two given compounds are identical

B) a) Explain the effect of magnetic anisotropy on aldehydic protons? **3**

b) What is chemical shift? How is it expressed? **2**

C) a) Give the structure of the following pyrimidine bases present in nucleic acid? **3**
1. Cytosine 2. Uracil 3. Thymine

b) Draw the structure of sugars present in DNA & RNA. **2**

D) a) Explain the controlled hydrolysis of nucleic acids. **3**

b) What are nucleosides? Draw the structure of Adenosine. **2**

E) An organic compound has the molecular formula C_4H_8O. Determine the index of its hydrogen deficiency and deduce its structural formula from the following spectral data. **5**
IR spectrum**:** It shows a sharp band at 1740 cm^{-1}
PMR spectrum**:** It shows a doublet at δ 1.1 ppm (6H), multiplet at δ 2.3 ppm (1H) and a doublet at δ 9.4 ppm (1H).

F) An organic compound has the molecular formula M.F: $C_8H_{10}O$. Determine the index of its hydrogen deficiency and deduce its structural formula from the following spectral data. **5**
IR Spectrum (cm^{-1}): 3500, 1600, 1570,760 & 710.
PMR Spectrum (in δ ppm): 1.6 (3H,d) , 4.9 (1H,q) , 7.4 (5H,m), 4.2 (1H,s,D_2O exchangeable). Suggest a structure for the compound and justify your answer.

Q.4 Attempt any four of the following. **20**

A) a) What is Ziegler-Natta catalyst? Explain the stereoisomerism taking example of polypropylene. **3**

b) Give the preparation and uses of PVC. **2**

B) a) Explain the following terms with example: **3**
i) Elastomers ii) Fibres iii) Plasticiser

b) Give any two biomedical uses of synthetic polymers. **2**

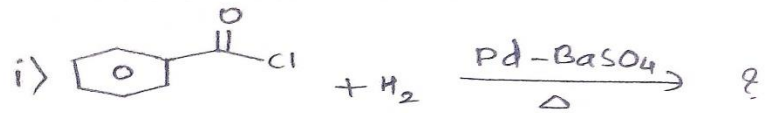
C) a) Give the structure, properties and uses of polyurethane. **3**

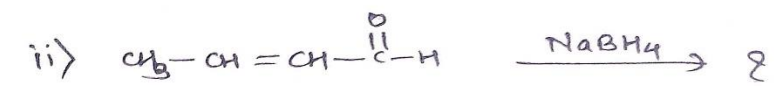
b) Write a note on vulcanisation of rubber. **2**

D) How is Raney-Ni prepared? Write its reduction reactions with following compounds? **5**
i) Alkenes ii) Nitriles iii) Nitro compounds

E) a) What is the action of $LiAlH_4$ on the following compounds: **3**
i) Acetone ii) Methyl cyanide iii) Nitro ethane

b) Complete the following reactions **2**





F) a) What is epoxidation? What is the reagent used. Explain the selectivity in the reaction with a suitable example. **3**

b) Write any two uses of SeO_2. **2**

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Q.5 A) Select the correct option and complete the following statements: (any five) **5**

a) A carbon atom, to which enantiotopic ligands are attached, is called……
i) Chiral centre iii) Ei mechanism
ii) Prochiral centre iv) None of above

b) The stereochemical equivalence or non-equivalence of different atoms or groups in a molecule is called.....
i) Topocity iii) Enantioselectivity
ii) Distereoselectivity iv) Stereoselectivity

c) S_Ni reaction proceeds via ……..of configuration.
i) Retention iii) Racemization
ii) Inversion iv) None of above

d) Meso tartaric acid has……..
i) Plane of symmetry iii) Alternating axis of symmetry
ii) Centre of symmetry iv) None of above

e) Hydroxylation of alkene by $KMnO_4$ is……reaction.
i) Stereoselective iii) Stereoselective and Stereospecific
ii) Stereospecific iv) None of above

f) The –CO-NH- linkage is called……
i) Peptide bond iii) Aldehyde bond
ii) Amine bond iv) Ketone bond

g) ……is used in Strecker synthesis.
i) K-phthalimide iii) Aldehyde
ii) Phthalimide iv) Phenyl hydrazine

h) The amino acids which are synthesized by human body are called……..α-amino acids.
i) Essential iii) Acidic
ii) Non-essential iv) Basic

Q.5 B) State whether true or false: (any five) **5**

a) D-glucose and D-galactose are epimers.
b) Alkyne is the product of Wittig reaction.
c) Beckmann rearrangement of ketoximes is stereospecific.
d) Pinacol rearrangement takes place in presence of base catalyst.
e) Glucose is a ketose.
f) Five moles of periodic acid are required per mole of D-Fructose.
g) Cellulose is a polysaccharide.

Q.5 C) Fill in the blanks with correct alternatives given in the bracket: (any five) **5**

(out-of-plane bending, deshielding, 1690-1720 cm^{-1}, polyphosphate chain, solvent, RNA, 3200-3600 cm^{-1}, cytoplasm, in-plane bending, three, standard, nucleus.**)**

a) Carbon tetrachloride is used as a ---------- in PMR spectroscopy.
b) ---------- helps in protein synthesis.
c) DNA is found in the ---------- of the cell.
d) The backbone of nucleic acid molecule is a ----------.
e) A broad absorption band due to -O-H stretching in alcohols appears in the region around ----------
f) For water molecule the number of possible modes of vibrations is ----
g) The presence of electron withdrawing groups causes ----------effect on the adjacent protons..
h) Rocking is a type of ---------- vibration.

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Q.5 D) Match the columns: (any five) **5**

Column A		Column B
a) Stabilizers	(i)	Cold rubber.
b) Buna-S rubber	(ii)	Chemoselective oxidising agent
c) Neoprene	(iii)	CaO
d) PHBV	(iv)	Allylic or benzylic bromination
e) Lindlar's catalyst	(v)	Elastomers
f) Adam catalyst	(vi)	Chloroprene.
g) NBS	(vii)	Biodegradable polymer
	(viii)	Partially reduction of alkynes
	(ix)	PtO_2

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Time: 3 hrs. **M. M.: 100**

N.B.:

1. **All** questions are **compulsory**.
2. **Figures** to the **right** indicate **full** marks.
3. Draw **neat** diagrams wherever **necessary**.
4. Symbols have usual meaning unless otherwise stated.
5. Use of **non-programmable** calculator is allowed.

Constants: Planck's constant (h) = 6.64 x 10^{-34} J-s;
Mass of an electron (m_e) = 9.10 x 10^{-31}Kg = 0.00055 amu
Charge on electron (e) = 1.60 x 10^{-19} C
Speed of light (c) = 3 x 10^{8} m/s
1 eV = 1.60 x 10^{-19} J

Q1. Attempt any **two**

(i) Discuss Gamow's theory of α-decay? **10**

(ii) (A) Explain how the velocity of α-particles is determined using magnetic spectrograph? **10**
(B) Write note on short range alpha particles.

(iii) Describe the detection of neutrino using Cowan and Reines experiment. **10**

(iv) Explain three different types of β-decay. Derive the energetic for K-capture process. **10**

Q2 Attempt any **two**

(i) Obtain expression for binding energy of a nucleus based on liquid drop model. **10**

(ii) What is γ ray spectra? Explain the selection rules in case of γ -decay. Also discuss the phenomenon of internal conversion. **10**

(iii) What are mass parabolas? For odd A nuclei, derive expression for the charge and mass of the most stable isobar. **10**

(iv) Describe Mossbauer effect using its experimental set up. **10**

Q3 Attempt any **two**

(i) What is natural fusion? Explain energy productions in stars using carbon cycle. **10**

(ii) Explain the Nuclear cycle in a thermal nuclear reactor and show how it leads to the Four factor formula. How does this formula get modified if the reactor fuel contains only U^{235} and no U^{238}? **10**

(iii) Explain construction and working of Van de Graff generator in detail with the help of schematic diagram. **10**

(iv) Describe the construction and working of Betatron. **10**

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Q4 Attempt any **two**

(i) Summarize the important experimental properties of the deuteron. **10**

(ii) Explain meson theory of nuclear Force. Using Heisenberg's uncertainty principle, estimate the mass of meson. **10**

(iii) What are elementary particles? Give the basis of their classification. **10**

(iv) (a) State conservation laws for various properties of elementary particles. **10**

(b) Give the basic properties of neutrinos and antineutrinos.

Q5. Attempt any **four**

(i) Explain what is Specific ionization and Stopping power. **05**

(ii) Explain continuous β-particle spectra. **05**

(iii) Write a note on nuclear isomerism. **05**

(iv) What are mirror nuclei? For the mirror nuclei, $^{15}_{7}N$ and $^{15}_{8}O$, calculate Coulomb coefficient. **05**

Given: M($^{15}_{7}N$) = 15.000108 amu, M($^{15}_{8}O$) = 15.00307amu,
m_n = 1.008665 amu, m_p = 1.007825

(v) If the fission process starts with the 3000 neutrons and the multiplication factor k = 1.05, calculate the number of neutrons present in the tenth generation. **05**

(vi) The radius of dees in the cyclotron is 35 cm and magnetic field is 3000 Gauss. What would be the velocity and energy of protons? **05**
Given: $m_{p=}$ 1.67 $\times 10^{-27}$Kg, q = 1.6 $\times 10^{-19}$C.

(vii) Write a short note on photon. **05**

(viii) Explain qualitatively the Quark model. **05**

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Duration 2 ½Hrs Marks: 75

N.B. : (1) All questions are compulsory.
(2) Figures to the right indicate marks.

1. (a) Attempt ANY ONE from the following: (8)
   (i) Let $f : (X, d) \longrightarrow (Y, d')$ be a function. Show that f is continuous at $p \in X$ if and only if for each sequence (x_n) in X converging to p, the sequence $(f(x_n))$ converges to $f(p)$ in Y.
   (ii) Let $f : (X, d) \longrightarrow (Y, d')$ be a function. Prove that f is continuous on X if and only if for each open subset G of Y, $f^{-1}(G)$ is an open subset of X.

   (b) Attempt ANY TWO from the following: (12)
   (i) Let (X, d) be a metric space and let $A \subset X$ be any non empty subset of X. Define a function $d_A : X \to \mathbb{R}$ as $d_A(x) = d(x, A)$, $\forall x \in X$. Show that d_A is a uniformly continuous function.
   (ii) Let $f : \mathbb{R}^2 \longrightarrow \mathbb{R}$ be a continuous map. Show that $g : \mathbb{R}^2 \longrightarrow \mathbb{R}$ defined by $g(x, y) = f(x + y, x - y)$ is continuous on $\mathbb{R}^2$.(Under usual metric of $\mathbb{R}$ and Euclidean metric of $\mathbb{R}^2$)
   (iii) Prove every function $f : (X, d_1) \longrightarrow (Y, d')$ where (X, d_1) is a finite metric space and (Y, d') is any metric space is continuous.

2. (a) Attempt ANY ONE from the following: (8)
   (i) Let (X, d) be a metric space and A, B be conncected subsets of X such that $A \cap B \neq \emptyset$. Prove that $A \cup B$ is a connected set.
   (ii) Prove that a metric space is connected if and only if every continuous function from X to $\{1, -1\}$ is a constant function.

   (b) Attempt ANY TWO from the following: (12)
   (i) If $f : (X, d) \longrightarrow (Y, d_1)$ is a continuous function where X is a connected metric space and Y is a finite metric space then show that f is a constant function.
   (ii) Which of the following subsets of $\mathbb{R}^2$ (distance being Euclidean) are connected and which are disconnected? Justify your answer.
   (I) $E = \{(x, y) \in \mathbb{R}^2 : xy = 1\}$ (II) $F = \{(x, y) \in \mathbb{R}^2 : xy = 0\}$
   (iii) Prove that in a normed linear space, an open ball $B(x, r)$ is a convex set.

3. (a) Attempt ANY ONE from the following: (8)
   (i) $\{f_n\}$ is a sequence of real valued functions defined on $S \subseteq \mathbb{R}$ such that $f_n \longrightarrow f$ uniformly on S. If each f_n is bounded on S, then prove that f is bounded on S and there exists $\alpha \in \mathbb{R}^+$ such that $|f_n(x)| \leq \alpha \ \forall \ n \in \mathbb{N}$ and $\forall \ x \in S$.
   (ii) (I) If $\{f_n\}$ is a sequence if real valued continuous functions on $S, S \subseteq \mathbb{R}$ such that $\sum_{n=1}^{\infty} f_n$ converges uniformly to f on S, then prove that f is continuous on S, and for $p \in S$, $\sum_{n=1}^{\infty} \lim_{x \longrightarrow p} f_n(x) = \lim_{x \longrightarrow p} \sum_{n=1}^{\infty} f_n(x)$.

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(II) Let $\sum_{n=1}^{\infty} f_n$ be a series of $R-$integrable functions on $[a,b]$, converging uniformly to f on $[a,b]$, then prove that f is $R-$integrable on $[a,b]$ and $\int_a^b f(x)\,dx = \sum_{n=1}^{\infty} \int_a^b f_n(x)\,dx$.

(b) Attempt ANY TWO from the following: (12)

(i) $f_n : [0,1] \longrightarrow [0,1]$ is defined by $f_n(x) = x * \chi_n(x)$ where $\chi_n(x) = \begin{cases} 0 & \text{if } x \notin \left[0, \frac{1}{n}\right] \\ 1 & \text{if } x \in \left[0, \frac{1}{n}\right] \end{cases}$.

Show that $\{f_n\}$ converges uniformly to 0 on $[0,1]$.

(ii) $f_n : [0,1] \longrightarrow \mathbb{R}, f_n(x) = \frac{x}{n}$. Show that $\{f_n\}$ is uniformly convergent on $[0,1]$. Also show that $\{f_n\}$ does not converge uniformly on $[0,\infty)$.

(iii) Show that the series $\sum_{n=1}^{\infty} \frac{x^n}{n!}$ is uniformly convergent on $[-A, A], A > 0$ but not uniformly convergent on $\mathbb{R}$.

4. Attempt ANY THREE from the following: (15)

(a) Let $f : [a,b] \to [a,b]$ is continuous on $[a,b]$ and differentiable on (a,b). If $\exists\ c \in \mathbb{R}$ with $0 < c < 1$ such that $|f'(x)| \leq c$, $\forall x \in (a,b)$ then prove that f is a contraction of $[a,b]$.

(b) Let (X,d) be a metric space and $f : X \longrightarrow \mathbb{R}$, ($\mathbb{R}$ with usual metric) is continuous on X. If $f(x_0) > 0$ for some $x_0 \in X$ then show that $\exists\ \delta > 0$ such that $f(x) > 0\ \ \forall x \in B(x_0, \delta)$.

(c) Show that $E = \{(x,y) \in \mathbb{R}^2 : x > 0, x^2 - y^2 = 1\}$ is path connected.

(d) Prove or disprove: If A and B are connected subsets of $(\mathbb{R}, d)$ where d is the usual distance, then $A \setminus B$ is also connected.

(e) $f_n : [0,1] \longrightarrow \mathbb{R}$ is defined as $f_n(x) = \begin{cases} n & \text{if } 0 < x < \frac{1}{n} \\ 0 & \text{otherwise} \end{cases}$.

(i) Find the pointwise limit f of $\{f_n\}$.

(ii) Is $\lim_{n \longrightarrow \infty} \int_0^1 f_n(x) = \int_0^1 f(x)dx$?

(iii) Does $\{f_n\}$ converge uniformly to f on $[0,1]$? State clearly the result used.

(f) If R is the radius of convergence of the power series $\sum_{n=0}^{\infty} c_n x^n$, then find the radius of convergence of the series $\sum_{n=0}^{\infty} \frac{(-1)^n}{n^2} c_n x^n$.

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Time: $2\frac{1}{2}$ hours **Total Marks:75**

Instructions:1) All questions are compulsory.
2) Figures to right indicate marks for respective sub questions

Q.1 A Answer any **ONE**

i) Define characteristic of a ring. Prove that the characteristic of a ring R is n if and only if the order of the multiplicative identity of R in $(R,+)$ is n. 08

ii) Show that every field is an integral domain. Further show that every finite integral domain is a field. 08

B Answer any **TWO**

i) Define unit and zero divisor. Prove that every non-zero element of $\mathbb{Z}_n$ is either a unit or a zero divisor. 06

ii) Let $R = M_2(\mathbb{Z})$ be the ring of all 2×2 matrices over the integers and let $S = \left\{\begin{bmatrix} a & a-b \\ a-b & b \end{bmatrix} : a, b \in \mathbb{Z}\right\}$. Show that S is a subring of R. 06

iii) Let R be an integral domain and $a, b \in R$. If $a^3 = b^3$ and $a^8 = b^8$ then show that $a = b$. Does this hold if $a^m = b^m, a^n = b^n$ and the greatest common divisor of m and n is 1. 06

Q.2 A Answer any **ONE**

i) Define prime ideal and maximal ideal of a ring. Prove that every maximal ideal in a commutative ring is a prime ideal. Give an example of a ring and a prime ideal of it, which is not maximal. 08

ii) Let A be a subring and B be an ideal of a ring R. Then show that $A \cap B$ is an ideal of A and $A/(A \cap B)$ is isomorphic to $(A+B)/B$. 08

B Answer any **TWO**

i) p) Show that a field has no ideals except $\{0\}$ and itself 06

q) Let R be a commutative ring with unity, such that only ideals of R are $\{0\}$ and itself. Prove that R is a field.

ii) Let $R = \left\{\begin{pmatrix} a & b \\ b & a \end{pmatrix} : a, b \in \mathbb{Z}\right\}$ be ring. Prove that $f: R \to \mathbb{Z}$ defined by $f\left(\begin{pmatrix} a & b \\ b & a \end{pmatrix}\right) = a - b$ is an onto ring homomorphism. Further, is ker f prime ideal? Is ker f maximal ideal? Justify. 06

iii) Show that an ideal M in a commutative ring R is maximal ideal if and only if R/M is a field. 06

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Q.3 A Answer any **ONE**

i) Prove that for any pair of non-constant polynomials $f(x), g(x) \in F[x]$ there exists unique $q(x), r(x) \in F[x]$ such that $f(x) = g(x)q(x) + r(x)$ where $r(x) = 0$ or $\deg r(x) < \deg g(x)$. 08

ii) Prove that in $\mathbb{Z}$ (the ring of integers) a non-zero non unit element p is irreducible if and only if p is prime. 08

B Answer any **TWO**

i) State Eisenstein's criteria and show that the p^{th} Cyclotomic polynomial $\phi_p(x) = x^{p-1} + x^{p-2} + \cdots\cdots + 1$ where p is prime is irreducible over $\mathbb{Q}$. 06

ii) Define prime element. Prove that in an integral domain R an element p is prime if and only if $< p >$ is a non-zero prime ideal of R. 06

iii) Let R be an integral domain and a be non-zero element in R. Prove that if $< a >$ is maximal ideal then a is irreducible. Is converse true? Justify your answer. 06

Q.4 Answer any **THREE**

i) Define nilpotent element. Show that integral domain has no non-zero nilpotent elements. 05

ii) Give examples: 05
a) of a finite ring which is not commutative.
b) of a ring R such that $a^2 = a$ for all $a \in R$.
c) of a ring of characteristic 4 and elements x, y in it such that $(x + y)^4 \neq x^4 + y^4$.

iii) Let R be a ring and $a \in R$ be a unit. Show that the map from R into itself given by $x \mapsto axa^{-1}$ is a ring automorphism. 05

iv) Find the maximal ideals of the ring $(\mathbb{Z}_{24}, +, .)$ 05

v) List all the polynomials of degree 2 over $\mathbb{Z}_3$ and classify them into reducible and irreducible polynomials. 05

vi) Determine units of $\mathbb{Z}[\sqrt{-5}]$ and show that $1 + 3\sqrt{-5}$ is irreducible but not prime in $\mathbb{Z}[\sqrt{-5}]$. 05

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[Time: 3 Hours] **[Total marks :100]**

N.B.: (1) All questions are compulsory.
(2) Figures to the right indicate full marks.
(3) Use of logarithmic table/non-programmable calculator is allowed.

1. Attempt **any four** of the following**:**

A. What is crystal field splitting? Explain with reference to tetrahedral complexes. **5**

B. Explain the following factors affecting crystal field splitting. **5**
i] Nature of the ligands.
ii]position of metal in transition series.

C. Explain the term crystal field stabilization energy [CFSE]. Calculate CFSE for d^8 and d^9 configurations in strong field octahedral complexes. **5**

D. Discuss any five merits of crystal field theory. **5**

E. Explain Jahn-Teller distortions in octahedral complexes with suitable example. **5**

F. Write a note on intensity of d-d transition as an evidence of covalent bonding in metal complex. **5**

2. Attempt **any four** of the following**:**

A. Discuss molecular orbital diagram of $[Fe(H_2O)_6]^{3+}$ complex and give its magnetic behaviour. **5**

B. Write a note on Steric effect on the stability of metal complexes. **5**

C. Explain charge transfer transitions in metal complexes. **5**

D. Write a note on S_N1 mechanism in ligand substitution reaction of octahedral metal complexes. **5**

E. Distinguish between thermodynamic and kinetic stability in metal complexes. **5**

F. Write a note on base hydrolysis in ligand substitution reaction of octahedral metal complexes. **5**

3. Attempt **any four** of the following**:**

A. Define organometallic compound. Write a note on multicentred electron deficient organometallic compound. **5**

B. Describe the method of preparation of organometallic compound by oxidative addition reaction. **5**

C. Write a note on Complex formation reactions of organometallic compounds. **5**

D. What is ferrocene? Explain structure of ferrocene according to valence bond theory. **5**

E. Write a note on any five chemical reactions of ferrocene. **5**

F. Differentiate between homogeneous and heterogeneous catalysis. **5**

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4. Attempt **any four** of the following**:**

A. Define metallurgy. Explain Hydrometallurgy with suitable example. **5**

B. What are the different methods used for concentration of ore? Discuss in detail Hydraulic Classifier Method. **5**

C. Name the steps involved in extraction of copper. Explain the electrolytic refining of copper. **5**

D. How inert gases are isolated by Charcoal Adsorption methods. **5**

E. Give the method of preparation and structure of following compound on the basis of VSEPR Theory: **5**
i) XeF_6
ii) XeO_3

F. Write a note on importance of sodium potassium ion pump in biological system. **5**

5. Answer the following:

A. Select the correct option and complete the following statements: (any five) **5**

a. CFSE for strong field octahedral complexes with d^5 configuration is ----------
a)-6Dq+4P b) -12Dq+3P c) -24Dq+3P d) -20Dq+2P

b. In Octahedral complex, d-orbital of central metal degenerates into ---------- energy levels
a) 1 b) 3 c) 4 d) 2

c. Jahn-Teller distortions are more common among the octahedral complexes with ----------distribution of electrons.
a) proportional b) symmetric b) asymmetric c) equal

d. Crystal field splitting energy in square planar complex is denoted as ---------
a) Δt b)Δsp c) Δq d) Δo

e. ---------- is a strong field ligand.
a)S^{2-} b) Cl^- c) CO d) F^-

f. In transition metal complexes, d-orbitals of the metal are affected by ----------
a)Metal b) Co-ions c)Ligands d)cations.

g. Colour observed for a complex is ---------- to the colour that is absorbed.
a)same b) complimentary c)alike d)identical

h. Electron spin resonance spectra of $[IrCl_6]^{2-}$ shows --------- curve
a)Double hump b) smooth c) Serrated d) linear

B. State whether true or false: (any five) **5**

a. $[Ti(H_2O)_6]^{3+}$ is low spin complex .

b. Number of microstates for p^1 configuration 21.

c. $\Delta l = \pm 1$is transition is Laporte allowed.

d. Ground state term for $1s^1$ is ^2S.

e. Complexes with polydentate ligands are more stable than those with unidentate ligands.

f. Associative mechanism for ligand substitution reaction form seven coordinate intermediate with pentagonal bipyramidal structure.

g. (2S-1) is called spin multiplicity.

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C. **Fill in the blanks with correct alternatives given in the bracket : (any five)** **5**

(M – C, increases, CH_3MgCl, oxidation, heterogeneous, reductive elimination, 2 C_5H_6 , Mannich.)

a. The essential requirement for an organometallic compound is the presence of at least one …….. bond

b. In preparation of organometallic compound by oxidative addition reaction, oxidation number of metal …….

c. ……. is the example of organometallic compound.

d. Condensation of ferrocene rings with formaldehyde and amine is called as …….. reaction.

e. During nitration ferrocene undergoes …… .

f. Fe + …… $\rightarrow (C_5H_5)_2Fe + H_2$

g. When the reactants and catalyst are in the different phase, catalyst is referred as ……

h. High formal positive charge on the metal and presence of bulky groups on the molecule, facilitates …… reactions.

D. **Match the column: (Any five)** **5**

Column A	Column B
a. Grinding	i. Source of β radiation
b. Frothing agent	ii. Incandescent electric bulbs
c. Acidic impurities	iii. Iron Deficiency
d. Bessemerisation	iv. Source of α radiation
e. Krypton Clathrates	v. Pulverization
f. Argon	vi. Skin pigmentation
g. Anaemia	vii. Pine oil
h. Tryosinase	viii. Used in treatment of cancer
	ix. Blister Copper
	x. Basic Flux

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Time: 2.5 Hours **Total Marks: 75**

N. B. 1) All questions are compulsory.
2) Use of a simple calculator is allowed.
3) Figures to the right indicate marks.

Q. 1 A) Attempt **any one** from the following. (8)

i) Let $\Omega \subset \mathbb{C}$ is a domain in $\mathbb{C}$. If $u, v : \Omega \to \mathbb{R}$ are such that
i) u_x, u_y, v_x, v_y exist and satisfy Cauchy Riemann equations
ii) u_x, u_y, v_x, v_y are continuous on Ω,
then prove that $f(z) = u(x, y) + iv(x, y)$ is analytic in Ω.

ii) If z_0 and w_0 are points in z and w plane respectively then show that
(a) $\lim_{z\to z_0} f(z) = \infty$ if and only if $\lim_{z\to z_0} \frac{1}{f(z)} = 0$.
(b) $\lim_{z\to\infty} f(z) = \omega_0$ if and only if $\lim_{z\to 0} f\left(\frac{1}{z}\right) = \omega_0$
(c) $\lim_{z\to\infty} f(z) = \infty$ if and only if $\lim_{z\to 0} \frac{1}{f\left(\frac{1}{z}\right)} = 0$.

B) Attempt **any two** from the following. (12)

i) If a function $f(z) = u(x, y) + iv(x, y)$ is analytic in a domain D. then show that its component function u and v are harmonic in D.

ii) Use $\epsilon - \delta$ definition of limit to show that

$\lim_{z\to 1-i}[x + i(x + y)] = 1$

iii) Does there exist a complex differentiable function $f = u + iv$ with real part $u(x, y) = xe^y$? Justify your answer.

Q.2 A) Attempt **any one** from the following. (8)

i) Suppose that a function f is analytic throughout a disk $|z - z_0| < R_0$, centred at z_0 and with radius R_0. Then prove that $f(z)$ has the power series representation $f(z) = \sum_{n=0}^{\infty} a_n(z - z_0)^n, |z - z_0| < R_0$, where $a_n = \frac{f^n(z_0)}{n!}$.

ii) Let A be an open, connected subset of $\mathbb{C}$ and $f: A \to \mathbb{C}$ be an analytic function in A. Let $z_0 \in A$ and $r > 0$ be such that $B(z_0, r) \subset A$. Then state and prove Cauchy Integral Formula for any $\omega \in B(z_0, r)$.

B) Attempt **any two** from the following. (12)

i) Let D be a simply connected domain in $\mathbb{C}$ and $f: D \to \mathbb{C}$ be an analytic function defined on D such that $f'(z)$ is continuous on D. If C is a simple closed curve in D then show that $\int_C f(z)\, dz = 0$.

ii) Give definition of $\sinh z$ and $\cosh z$ and prove that

$$\cosh^2 z - \sinh^2 z = 1.$$

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iii) Evaluate $\int_C \frac{2z+3}{z} dz$, where C is the
   a) Upper half of the circle $|z| = 2$
   b) Lower half of the circle $|z| = 2$
   c) The whole circle $|z| = 2$ in anti-clockwise direction.

Q.3 A) Attempt **any one** from the following. (8)

i) If z_1 is a point inside the circle of convergence $|z - z_0| = R$ of a power series $\sum_{n=0}^{\infty} a_n(z - z_0)^n$ then show that the series must be uniformly convergent in the closed disk $|z - z_0| \leq R_1$, where $R_1 = |z_1 - z_0|$.

ii) Let C be a simple closed curve in the interior of the disc of convergence of the power series $S(z) = \sum_{n=0}^{\infty} a_n (z - z_0)^n$ and let $g(z)$ be any function which is continuous on C. Then prove that, the series $\sum_{n=0}^{\infty} g(z)a_n(z - z_0)^n$ can be integrated term by term over C and $\int_C g(z)S(z)dz = \sum_{n=0}^{\infty} \int_C g(z)a_n(z - z_0)^n dz$.

B) Attempt **any two** from the following. (12)

i) State Cauchy's Residue Theorem and using it evaluate $\int_C \frac{dz}{(z^2+1)(z^2+4)}$ where C is the circle $|z| = 1.5$

ii) Expand $f(z) = \frac{1}{z(z-1)}$ as a Laurent series for the annular domains:

(i) $0 < |z| < 1$ (ii) $1 < |z|$ (iii) $0 < |z - 1| < 1$

iii) Let $\sum a_n z^n$ has radius of convergence R. Find the radius of convergence of
   a) $\sum_{n=0}^{\infty} n^3 a_n z^n$ b) $\sum_{n=0}^{\infty} a_n z^{3n}$ c) $\sum_{n=0}^{\infty} {a_n}^3 z^n$

Q. 4 Attempt **any three** questions from the following. (15)

i) Represent the $|z + 1| = |z - i|$ subset of $\mathbb{C}$ in the plane.

ii) Show that $z(t) = z_0 + tv$ and $Re\big((z - z_0)i\,\bar{v}\big) = 0$ represents the same line in $\mathbb{C}$

iii) Find the image of $\frac{1}{5} \leq |z| \leq 2$ under the reciprocal map $w = \frac{1}{z}$ on extended plane.

iv) Determine whether the set of points $\{-1, -i, i, 2 - i\}$ lies on a circle.

v) Find $\underset{z=0}{Res} f(z)$ where $f(z) = \frac{\cot z}{z^4}$ (using the idea of power series division).

vi) With the help of a suitable power series, show that

$$f(z) = \begin{cases} \frac{\sin z}{z} & z \neq 0 \\ 1 & z = 0 \end{cases}$$

is entire. Use it to show $\lim_{z \to 0} \frac{\sin z}{z} = 1$.

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[Time : 3Hours] **[Total marks :100]**

N.B. : (1) All questions are compulsory.

(2) Figures to the right indicate full marks.

(3) Use of logarithmic table/non-programmable calculator is allowed.

Physical Constants:

$N = 6.022 \times 10^{23}$ $c = 3.0 \times 10^8$ m/s

$R = 8.314$ J/K mol $h = 6.626 \times 10^{-34}$ Js

$\frac{2.303\,RT}{nF} = \frac{0.0592}{n}$ at 298 K

1. Attempt **any four** of the following**:**

A. Define activity and activity coefficient of an electrolyte. Give the expression for activity of the following electrolytes **5**

i) $AlCl_3$ ii) $CuSO_4$ iii) Na_2SO_4

B. Explain the function of the salt bridge. Why is a saturated solution of KCl generally used in preparation of salt bridge? **5**

C. Derive an expression for the e.m.f of an electrode concentration cell of the following cell **5**

$Cd(Hg)a_1 \,/\, CdSO_{4\,(aq)} \,/\, Cd(Hg)a_2$

D. Derive an expression for the e.m.f of an electrolyte concentration cell with transference reversible with anion **5**

E. Calculate the mean activity coefficient of NaCl in a solution containing $0.02 mol/dm^3$ of NaCl and $0.05 mol/dm^3$ of $CaCl_2$ (A=0.509 at 298K for water) **5**

F. Define hydrogen overvoltage. In the electrolysis of 2N sulphuric acid the hydrogen overvoltage at lead cathode was found to be 0.352V at 298 K for a given current density what will be the hydrogen overvoltage if the current density is increased six times its present value for the same cathode under the same conditions. (Given: b = 0.12 V at 298 K) **5**

2. Attempt **any four** of the following.

A. Explain the terms **5**

i) Monomer

ii) Polydispersity Index

iii) Degree of polymerization

B. In a polymer sample 30% molecules have a molecular weight 20,000, 40% have molecular weight 30,000 and 30 % have 60,000. Calculate number average and weight average molecular weights for given polymer. **5**

C. Explain the classification of polymers on the basis of the structure. **5**

D. Explain the viscosity method for determination of molecular weight of polymers. **5**

E. Explain number average molecular weight and weight average molecular weight **5**

F. Describe advantages and applications of light emitting polymers. **5**

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3. Attempt **any four** of the following**:**

A. Explain the Compton effect using Quantum mechanics and also give limitations of Classical mechanics in explaining it. **5**

B. Find the eigen value and state whether the function is an Eigenfunction for then operator $\frac{d^2}{dx^2}$ for the following function. **5**

i) 6cos4x ii) $3e^{5x}$

C. Write a note on: **5**

i) Wave matter duality of matter ii) Heisenberg Uncertainty Principle

D. What is a commutative operator? Explain and prove it with an example. **5**

E. Discuss the classification of conductor, semiconductor and insulator on the basis of band gap. **5**

F. Explain production of hydrogen gas using electrolysis of water and mention advantages of hydrogen gas as fuel. **5**

4. Attempt **any four** of the following**:**

A. Explain the working of NMR Spectrometer with the help of a neat labelled diagram **5**

B. Derive the fundamental equation of NMR spectroscopy **5**

C. Explain the relaxation processes in NMR spectroscopy. **5**

D. Explain the principle of ESR spectroscopy **5**

E. Draw diagram of ESR spectrometer and explain functions of following in ESR spectrometer i) Klystron oscillator ii) Sample cavity iii) Crystal detector **5**

F. Explain fine splitting and hyperfine splitting of hydrogen ESR spectrum. **5**

5. Answer the following:

A. Select whether the following statements are **true** or **false (Any five)** **5**

a. For a concentration cell, the standard emf of the cell is unity

b. Reduction involves the decrease in the oxidation state of the metal ion

c. The deviation of an electrolyte solution from its ideal behaviour is called as activity

d. A plot of log of mean activity coefficient versus square root of ionic strength gives a positive slope

e. The value of liquid junction potential depends on the volume of the electrolyte in a galvanic cell

f. The minimum external potential that must be applied between electrodes in an electrolytic solution to bring continuous electrolysis is called as decomposition potential

g. The cause of polarization phenomenon in an electrolytic cell is due to back emf

h. Overvoltage is dependant on temperature

B. Fill in the blank with appropriate words **(Any five)** **5**

a. ——— is an example of natural polymer (nucleic acid, PVC, Rayon, polyester)

b. Thermoplast are the polymers which soften when heated and_____ when cooled. (brittle, harden, blackned, colourless)

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c. Weight average molecular weight is defined by symbol _____
($\overline{M_n}$, $\overline{M_w}$, $\overline{M_z}$, $\overline{M_v}$)

d. Heating rubber with sulphur is called_____
(Galvanization, Vulcanization, Sulphonation, Bessmerisation)

e. Which is a naturally occurring polymer _____
(polythene, protein, PVC, Polypropylene)

f. In linear polymers monomeric units are ——— together (break up, branched,cross linked, linked)

g. PVC is an example of———— polymer
(inorganic, organic, bio-organic, natural)

C. Select and write the appropriate answer. **(Any five)** **5**

a. According to Quantum mechanics, ejection of electrons from metal in Photoelectric effect is dependant on_____ of the radiation
a) Intensity b) Frequency c) temperature

b. In Black body radiation as temperature of the body increases, _____of the emitted radiation
a) wavelength and intensity increase
b) wavelength and intensity decrease
c) wavelength decreases, intensity increases

c. The wave function defined for a system has to be ———
a) single valued b) infinite c) discontinuous

d. Which of the following is not correct about standing waves?
a) amplitude vary with time b) confined in a space c) Do not propagate

e. If operator satisfies, $\hat{A}\,[f(x) + g(x)] = \hat{A}\,f(x) + \hat{A}\,g(x)$, operator is said to be —-
a) commutative b) linear c) harmonic

f. Which of the following is a nonrenewable source of energy?
a) Tidal b) CNG c) Solar

g. A solar cell works on the principle of
a) Photovoltaic effect b) Photoelectric effect c) Thermoelectric effect

h. Which of the following is an advantage in using hydrogen as a future fuel?
a) transportation b) high calorific value c) storage

D. **Match the column:** **(Any five)** **5**

Column A		**Column B**
a. C_{12}^6	i.	2.0023
b. Precessional angular frequency	ii.	I = ½
c. Degenerate energy level	iii.	Tetramethylsilane(TMS)
d. D_1^2	vi.	ω_o
e. N_7^{15}	v.	I = 1
f. g value of free electron in ESR	vi.	Absence of magnetic field
g. Reference compound in NMR	vii.	2.2003
	viii.	I=0
	ix.	Presence of magnetic field
	x.	I = $\frac{3}{2}$

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