(Year - April 2024)

TYBSC - chemistry

SEM - V

Pages - 15

[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:

$N = 6.023 \times 10^{23}$

$F = 96500$ coulombs

$c = 3 \times 10^{8}$ m/s

$R = 8.314$ J / K/mol

$h = 6.626 \times 10^{-34}$ J.s

Charge on electron $= 1.66 \times 10^{-19}$ C

Mass of an electron $= 9.1 \times 10^{-31}$ kg

$2.303RT / F = 0.05916$ at 298K

$\pi = 3.142$

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

A. Find expression for activity of uni : univalent type of electrolyte in terms of molality and mean ionic activity coefficient of electrolyte. **5**

B. What are chemical cells? How are they classified? Give example for each type. (Cell representation is expected) **5**

C. Derive an expression for the emf of gas electrode concentration cell reversible to cation. **5**

D. A solution is prepared by mixing 0.01 *m* NaCl and 0.005 *m* Na_2SO_4. Calculate the activity coefficient of NaCl in this solution. (Given: A = 0.509 for aqueous solution at 298 K) **5**

E. Explain the terms i) Polarization ii) Overvoltage **5**

F. Explain Tafel's theory of hydrogen overvoltage. **5**

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

A. How are polymers classified based on structure? **5**

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

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

D. What are antioxidants? How are they classified? **5**

E. Write a note on LEP. **5**

F. Equal weights of polymer molecules each of molecular weight 30,000 g/mol and 40,000 g/mol are mixed. Calculate $\bar{M}n$ and $\bar{M}w$. **5**

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

A. What are eigen functions and eigen values? Show that $\psi = [e^{-3x}]$ is an eigen function of the operator $\frac{d^2}{dx^2}$ and not for 'ln.' 5

B. What are the salient features of Photoelectric effect? Explain based on Quantum theory. 5

C. What are Progressive and standing waves? Obtain an expression for amplitude of a standing wave. 5

D. What will be the uncertainty in the position of an electron, (mass = 9×10^{-31} kg) moving at 300 ms^{-1} with an accuracy of 0.001 percent? 5

E. Explain 'Hydrogen is a clean and inexhaustible energy". 5

F. Explain the principle of Photovoltaic conversion with p-n junction, with the help of a diagram 5

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

A. Write a note on nuclear spin with respect to NMR. 5

B. Explain the working of NMR spectrometer. 5

C. What are different types of relaxation processes in NMR? 5

D. What is ESR spectroscopy? 5

E. Describe the parts of ESR spectrometer. 5

F. Explain the hyperfine splitting ESR spectra of deuterium 5

5. **Answer the following:**

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

a. The value of activity coefficient for HCl solution is greater than one.

b. In case of chemical cell without transference, salt bridge is required for connecting two half cells.

c. The ionic strength is product of molarity and valency.

d. In electrochemistry polarization is hypothetical phenomenon.

e. For galvanic cells the value of $E°_{cell}$ is always zero.

f. With increase in current density the overvoltage value also increases.

g. Transport number for an electrolyte can be determined using electrolyte concentration cell with transference type of galvanic cells.

h. Debye Huckel theory deals with ionic strength and activity coefficient of the solution.

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

a. ------- is a natural polymer.
(Cellulose, PVC, Rayon, terylene)

b. Starch is a -------- polymer.
(Natural, synthetic, semi-synthetic, thermoplast)

c. ------ is an elastomer.
(Vulcanized rubber, nylon, silk, teflon)

d. Weight average molar mass is denoted as--------
(M_n, M_z, M_l, M_w)

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e. ------prevents build-up of static electricity in polymers
(Antistatic agents, stabilizers, antioxidants, colorants)

f. ---------is a semi-synthetic polymer.
(PVC, silk, cotton, cellulose nitrate)

g. ------- is used to determine molecular weight of polymer.
(Ostwald Viscometer, conductometer, potentiometer, pH-meter)

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

a. Quantum mechanics is the branch of physics which deals with physical phenomena at
- i. Microscopic scales
- ii. Milli scales
- iii. Nanoscopic scales
- **iv.** Megascopic scales

b. Intensity is the total radiation emitted per
- i. Unit surface area
- ii. Meter
- iii. Unit volume
- iv. kilogram

c. Matter waves do not travel in
- i. Space
- ii. Water
- iii. Solids
- iv. vacuum

d. A wave function has.
- i. Positive value
- ii. Negative value
- iii. Both positive and negative value
- **iv.** Constant value

e. Boundary Condition are used to find out
- i. The wave function of the standing waves
- ii. State of the wave
- iii. Distance travelled by the wave.
- iv. Position of wave

f. The cathode and anode during the electrolysis of water is separated by a
- i. Junction
- ii. Condenser
- iii. Diaphragm
- iv. sheath

g. The band possessed by conduction electrons is called
- i. Valence band
- ii. Conduction band
- iii. Forbidden energy gap
- **iv.** Equivalent band

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h. A semiconductor with excess number of holes is called----------

i. p-type semiconductor
ii. q-type semiconductor
iii. n-type semiconductor
iv. h-type semiconductor

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

a.	$_2He^4$	**i.**	Parallel orientation
b.	$_7N^{14}$	**ii.**	Gyromagnetic ratio
c.	High energy	**iii.**	Lande splitting factor
d.	Klystron oscillator	**iv.**	I=0
e.	g	**v.**	2 peaks
f.	ESR spectra of hydrogen	**vi.**	I=1
g.	γ	**vii.**	Anti-parallel orientation
		viii.	ESR spectrometer
		ix.	3 peaks
		x.	I= 1/2

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TYBSC - chem - Sem V

(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) Explain the term quality control and quality assurance.

B) Calculate mass percent composition of each element in potassium ferrocyanide. $K_4Fe(CN)_6$
(Given: atomic weight of K = 39, Fe = 55.85, C = 12, N = 14)

C) Concentrated H_2SO_4 has specific gravity of 1.71 $g.cm^{-3}$ and it contains 80% w/w of H_2SO_4. Calculate 1) Molar concentration 2) Normal concentration
(Given atomic weight of H = 1, S = 32, O = 16)

D) Explain the importance of quality concept in industry.

E) Describe the sampling of immiscible and flowing liquid.

F) Discuss different equipment used for sampling of compact solid.

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

A) Calculate the potential of the system in the titration when equal volumes of equimolar Fe(II) and Ce(IV) solutions are mixed.
($E^0_{Pt|Fe+2,Fe+3} = +0.771V$, $E^0_{Pt|Ce+3,Ce+4} = +1.440V$)

B) 10.0 cm^3 0.1 M Fe (II) solution is titrated with 0.02 M $KMnO_4$ at pH = 1. Calculate the potential when
i) 9.9 cm^3 of 0.02 M $KMnO_4$ added
ii) 10.1 cm^3 of 0.02 M $KMnO_4$ added
Given: $E^0_{Pt/Fe^{3+},Fe^{2+}} = +0.771V$, $E^0_{Pt/MnO_4^-,Mn^{2+}} = +1.510$ V

C) What are redox indicators? Explain the use of any one redox indicator.

D) What are the factors which increase the selectivity of EDTA as titrant. Explain any two.

E) Explain the following types of EDTA titrations:
i) Back titration ii) Substitution titration.

F) Discuss the theory of metallochromic indicators. What are the requirements of metallochromic indicators?

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

A) With the help of a diagram explain the working of hollow cathode lamp.

B) Discuss the principle of Atomic Absorption Spectroscopy. Explain the role of rotating chopper in AAS.

C) Explain phosphorescence. Give two applications of phosphorimetry.

D) Explain Jablonski diagram of energy levels in a molecule.

E) Discuss the working of nephelometry with the help a labelled diagram.

F) Explain: - 1) Turbidimetric titrations 2) Phase titrations

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

A) Explain the principle of solid phase extraction. Give its advantages 20

B) Discuss any two factors affect ng solvent extractions.

C) Explain the terms used in HPLC i) isocratic elution ii) gradient elution. Give any three applic tions of HPLC

D) Explain the principle of HPLC . Discuss UV detector used in HPLC.

E) Give applications and limitations of HPTLC.

F) Name the steps involved in HPTLC. Write a note on fluorimetric detector used in HPTLC.

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

a) _____ cannot be used for validation of analytical method.
i) Reference material ii) Certified reference material iii) LR grade

b) The reagent of highest grade of purity is _____ grade.
i)AR ii) GR iii) LR

c) 30ppm means _____.
i) 30 mg ii) 30 mg/cm^3 iii)30mg/dm^3

d) 1M $Al(OH)_3$ solution is equivalent to _____ N $Al(OH)_3$ solution.
i) 1 ii) 3 iii) 0.1

e) _____ method is mostly used to draw sample from a cylinder filled with gas at high temperature.
i) Flushing ii) Static iii) Displacement

f) The process of rolling and quartering is used for decreasing _____ .
i) particle size ii) sample size iii) Bulk ratio

g) _____ is used for sampling of particulate solid.
i) Auger sampler ii) Concentric tube thief iii) Geo sampler

h) _____acid is excellent solvent for dissolution of many metal oxides and metals above hydrogen.
i) Hydrochloric ii) Sulphuric iii) Perchloric

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

a) Sulphuric acid is added to reduce $E^0_{Pt/Fe^{3+},Fe^{2+}}$ in the titration between Fe(II) and potassium dichromate.

b) Nernst's equation is applicable only at equivalence point in redox titrations.

c) Equivalent point potential is independent of concentrations of reactants and products in titration of Fe(II) against MnO_4^{-1}.

d) Ferroin contains 1,10-phenanthroline.

e) EDTA does not form 1:1 complex with most of the metal ions.

f) $K_{MY} = K'_{MY}$ when $\alpha_4 = 0$

g) In the titration of Ca^{+2} against EDTA, concentration of Ca^{+2} is zero at equivalence point.

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

(alkali & alkali earth metals, phosphorescence, turbidimeter, turbidance, toxic metals, hollow cathode lamp, low, conjugated double)

a) AAS is used to detect _____ like Cu, Ni, Zn and Hg in food products.
b) Flame photometry is extensively used for the estimation of _____.
c) In AAS the source of radiation is _____.
d) Delayed re-emission of absorbed radiation is called _____.
e) Phosphorimetric experiments are normally carried out at _____ temperature.
f) The instrument used to measure turbidance is known as _____.
g) Molecules having _____ bond are suitable for fluorescence and Phosphorescence.
h) A turbidimeter measures _____ as a function of concentration of suspension.

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

Column A		Column B	
a)	Neutral chelate	(i)	Detection of separated component using scanning instrument
b)	Powder silica	(ii)	Extraction of uranyl nitrate
c)	HPLC	(iii)	Remove impurities from solvent
d)	Multistage separation	(iv)	$pH_{1/2}$
e)	HPTLC	(v)	Reciprocating pump
f)	TBP solvent	(vi)	Countercurrent extraction
g)	Precolumn	(vii)	Solid phase extraction
		(viii)	Easily extracted in water
		(ix)	Easily extracted in organic solvent

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TYBSC - sem - V - chemistry

[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.

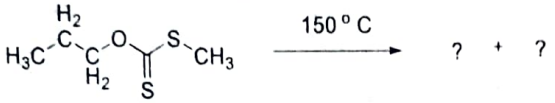
Q.1 **Attempt any four of the following.** **20**

A) a) Discuss the $B_{AC}2$ mechanism of hydrolysis of esters. 3

b) Explain the Chugaev reaction with a suitable example. 2

B) a) Discuss the stereochemistry of NGP with a suitable example. 3

b) Complete the following reaction and name the reaction involved. 2



C) Distinguish between: 5

i) Nucleophilicity and basicity

ii) Transition state and Reaction intermediate

D) What are pericyclic reactions? List how they are classified? Explain electrocyclic reactions with a suitable example. 5

E) With the help of a well labelled Jablonski diagram explain any three relaxation (decay) processes which an electronically excited molecule undergoes to loose energy. 5

F) a) Explain the Norrish type-I reaction at room temperature. 3

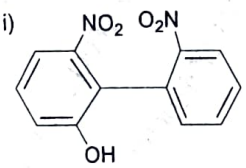
b) Distinguish between thermal and photochemical reactions. 2

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

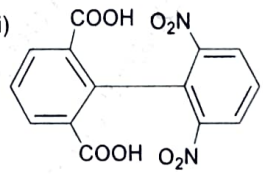
A) Write a note on stereochemistry of allenes. 5

B) a) State whether the following compounds are optically active or optically inactive. Justify your answer. 3

i)



ii)



b) Define centre of symmetry with an example. 2

C) Give the Skraup synthesis for the preparation of quinoline. Write the reaction of quinoline with nitrating mixture. 5

D) Convert pyridine to pyridine-N-oxide. Draw its resonating structures. What is the action of pyridine-N-oxide on: 1) SO_2Cl_2 and 2) $NaNH_2$ in Liq.NH_3 5

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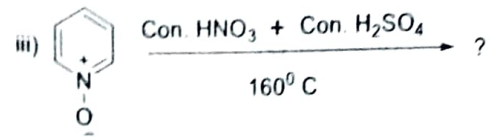
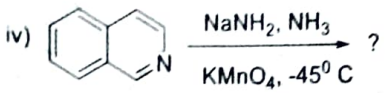
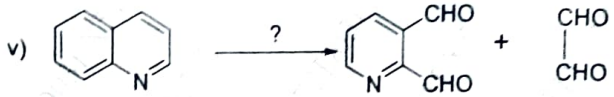
E) Complete the following reactions -

i) 

ii) 

iii) 

iv) 

v) 

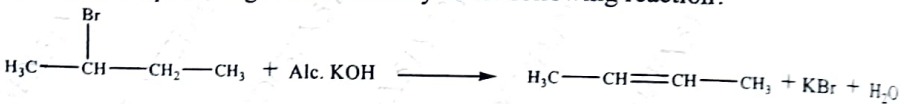
F) What are Agrochemicals? How are they classified? Write the synthesis of Indole-3-acetic acid.

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

A) a) Explain chemoselective reaction with a suitable example.
b) How is the theoretical yield calculated?

B) a) Define multicomponent synthesis? Write the Biginelli pyrimidone synthesis.
b) Mention any two criteria for an ideal organic synthesis.

C) a) Explain how adipic acid is prepared from D-glucose using green chemical reactions.
b) Calculate the percentage atom economy of the following reaction?



(Atomic Weights: C=12, H=1, O=16, K=39, Br=80)

D) Give the synthesis of the following compounds using a suitable starting material.

a) o-nitroaniline and p-nitroaniline.

b) Tert-butyl alcohol using a suitable Grignard reagent.

E) Write the structural formula for each of the following compounds:

1. Bicyclo [3.3.0] octane.
2. Spiro [2.4] hept-4, 6-diene.
3. 6, 6'-difluorodiphenyl-2, 2'-dicarboxylic acid.
4. 1-chloro-1, 2-pentadiene.
5. Quinoline-3-carboxaldehyde.

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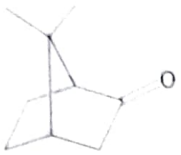
F) Give the IUPAC names for each of the following compounds 5

1. 

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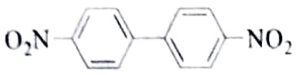
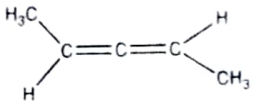
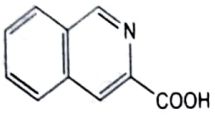
3. 

4. 

5. 

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

A) a) Give the synthesis of citral from methyl heptenone. 3
b) Give analytical evidence to prove that both the nitrogen atoms in nicotine are tertiary. 2

B) a) Give the reaction for Hofmann exhaustive methylation and degradation of pyrrole. 3
b) How will you prove that the side chain in nicotine is a pyrrolidine nucleus? 2

C) a) Give the Ott's synthesis of Adrenaline. 3
b) Give any one analytical evidence to prove that citral is an α, β-unsaturated aldehyde. 2

D) a) Give the synthesis of nicotine from nicotinic acid. 3
b) Give analytical evidence to prove that Citral has a carbonyl group. 2

E) a) Explain chromophore-chromophore interaction with a suitable example. 3
b) State the effect of solvent on λmax values with a suitable example. 2

F) a) Explain the fragmentation of the 2- methyl pentane. 3
b) What is molecular ion peak? Give its importance. 2

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

a) Cope elimination is observed in……
i) N-substituted amide ii) Aromatic ketoxime
iii) Tertiary amine oxide iv) N-substituted amine

b) All nucleophiles are……..
i) Lewis acids ii) Lewis bases
iii) Neutral iv) Electron pair acceptor

c) In NGP the stereochemistry of product is…….
i) Changed ii) Retained
iii) Inverted iv) None of the above

d) ……..is a thermodynamic term.
i) Electrophilicity ii) Nucleophilicity
iii) Basicity iv) Transition state

e) Which of the reaction is a thermal decomposition of xanthate esters?
i) Cope ii) Chugaev
iii) Pyrolysis of acetates iv) Favorski

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f) Benzophenone reacts with isopropyl alcohol in presence of light to form benzpinacol an example of .....
   i) Photoreduction ii) Photooxidation
   iii) Photosensitization iv) Isomerization

g) In which of the following reaction carbon monoxide is eliminated as a by-product
   i) Norrish type-I at room temperature ii) Norrish type-I at elevated temperature
   iii) Norrish type-II iv) Di-pi methane rearrangement

h) What does ISC stands for?
   i) Internal System Crossing ii) Inter-System Crossing
   iii) Intra-System Crossing iv) Internal Soft Crossing

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

a) Cumulenes having odd number of double bonds shows geometrical isomerism.
b) Trans-1,3-Dimethyl cyclobutane is achiral.
c) DDT is an organic insecticide.
d) Active component of neem oil is Azadirachtin.
e) In quinoline electrophilic substitution takes place at 2- position.
f) Isoquinoline is also known as 2-azanaphthalene.
g) The dipole moment of pyridine N-Oxide is more than pyridine.

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

(linear, green catalyst, super criticalCO_2 , covalent bond, ultra sound, larger, smaller, Cumulene , dimethyl carbonate, convergent.)

a) Synthesis of benadryl is an example of ---------- synthesis.
b) Sonication is the term used for the reaction carried out using ----------
c) The green reagent used for the selective methylation of active methylene compounds is ----------
d) In biphenyl two phenyl rings are bonded by a single ----------
e) In 6-methoxy spiro [3.4] octane the substitution is on the ---------- ring
f) Butatriene is classified as ----------
g) Enzymes are examples of ----------
h) Dry cleaning of the clothes can be carried out using ----------

Q.5 D) Match the columns: (Any five)

	Column A		Column B
a)	α-Pinene	i	-OH group
b)	Atropine	ii	2-methyl butadiene
c)	Hormones	iii	Belladona alkaloid
d)	Citral-a	iv	Secretion of ductless glands
e)	Isoprene	v	Monoterpenoids
f)	Base peak	vi	Geranial
g)	Auxochrome	vii	Neral
		viii	>C=O group
		ix	Highest peak

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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

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

A.	Discuss in brief the drawbacks of Valence bond theory.[Any 5 points]	5
B.	What is the basis of crystal field theory? Explain the crystal field splitting in octahedral complexes	5
C.	What do you mean by Δo ? How is it measured ?	5
D.	Define crystal field stabilization energy [CFSE]. Calculate CFSE for d^5 and d^8 configurations in strong field octahedral complexes.	5
E.	Explain the effects of crystal field splitting with respect to ionic radii of transition metal complexes.	5
F.	Explain: - "Electronic spin resonance spectra [ESR] is an evidence for covalent bonding in complexes.".	5

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

A.	Draw and explain a neat labelled molecular orbital diagram for Hexa fluroferrate (III) ion. $[FeF_6]^{3-}$	5
B.	Explain L→M π interactions with suitable example.	5
C.	Explain the effect of Nature of Co-ordinating groups or ligands on stability of complexes.	5
D.	i.Explain acid hydrolysis or aquation reaction in octahedral complexes .	2
	ii.Discuss any two factors which favours SN^1 mechanism for acid hydrolysis.	3
E.	What are the different types of electronic transitions? Discuss in detail d-d transitions or intra metal transitions.	5
F.	i. Explain the term 'microstates'. Calculate the number of microstates for p^2 configuration	3
	ii. State any two rules for determining the ground state terms.	2

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

A.	How will you prepare organometallic compound by oxidative -addition reaction?	5
B.	Write a note on sigma bonded covalent organometallic compound.	5
C.	What is metallocene? Give any one method of preparation of ferrocene.	5
D.	Explain the sulphonation and alkylation reaction of ferrocene.	5
E.	Discuss heterogeneous catalysis .	5
F.	Write a note on hydrogenation of alkene using Wilkinson's catalyst.	5

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

A. What is meant by term metallurgy? Explain self-reduction process in pyrometallurgy 5

B. Name any two ores of copper. Explain the concentration and roasting methods used for extraction of copper. 5

C. Explain Liquation process and Electro refining process in purification of metals. 5

D. Explain with suitable diagram Dewar's charcoal method for the separation of Nobel gases from atmosphere. 5

E. Give the methods of preparation and structure of XeO_2F_2. 5

F. Describe the role of Fe^{2+} and Cu^{2+} in biological system. 5

5. **Answer the following:**

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

a. In an octahedral complexes e_g orbital experiences minimum repulsions from ligands.

b. CFSE for a high spin octahedral complex with d^5 configuration is 0Dq.

c. $Fe(CN)_6]^{3-}$ is a high spin complex.

d. In an square planar complex the d- orbitals splits in 4 levels.

e. The splitting parameter of an octahedral complex is $\Delta o = 20$ Dq

f. The arrangement of ligand in the order of increasing field strength is called as Fajans – Tschida Spectrochemical series.

g. The enthalpies of formation of more stable ethylene diamine complexes is higher.

h. The high intensities of optical absorption bonds are due to d-d transitions.

B. Fill in the blank with appropriate words given in the bracket **(Any five)** 5
[charge, L→ Mπ , ring, substitution, negative, non-bonding, allowed, labile,]

a. t_{2g} orbitals from metal, form _____ molecular orbitals.

b. If molecular orbitals combine with maximum _____ overlapping, they form antibonding molecular orbitals.

c. Chelate is ____compound.

d. Stability of complexes increases with increase in_____ of the metal ion.

e. The reaction which involve a change in the composition of co-ordination sphere without any permanent change in the oxidation state of the metal are called _____ reactions.

f. Inner orbital complexes with vacant inner 'd' orbitals are_____

g. Transitions which involve a change in azimuthal quantum number are Laporte _____ .

h. The type of interactions involving ligands which are electron donors are called as _____ interactions.

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

a. The essential requirement for a organometallic compound is the presence of at least one _____ bond
a) M-C b)M-M c) C-C d)C-H

b. In preparation of organometallic compound by oxidative addition reaction, oxidation number of metal _____.
a) decreases b) increases c) remain same d) always became zero

c. The reaction of organometallic compound with conc H_2SO_4 is known as_____.
a) alkylation b) sulphonation c) arylation d) Complex formation

d. Metallocene informally also called as _____.
a) one-layer compound b) Sandwich compound
c) uniform compound d) homogeneous compound

e. The metal -hydrogen exchange reactions are referred as _____ reactions.
a) Oxidative additions b) Transmetallation c) Metathesis d) Metallation .

f. A transition metal act as good catalyst, when it shows _____oxidation state.
a) variable b) fixed c) only zero d) only +1

g. In Homogeneous catalysis, if reactants and products are in solid phase then catalyst may be in _____phase only.
a) solid b) liquid c) gaseous d) changing

h. Complete the reaction by choosing correct option
Fe + _____ $\rightarrow (C_5H_5)_2$ Fe + H_2
a) $2C_5H_6$ b) $2C_6H_6$ c) CH_4 d) CO_2

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

a.	Chalcopyrite's	i.	Square Planar Geometry
b.	Ore dressing	ii.	Copper deficiency
c.	Gangue	iii.	Tetrahedral Geometry
d.	XeF_4	iv.	Concentration of Ores
e.	XeO_4	v.	Used in electronic tubes
f.	Krypton-85	vi.	Iron deficiency
g.	Wilson disease	vii.	Non-Metallic Impurities
h.	Oxygen transfer	viii.	Copper Ore
		ix.	Purification of Ores
		x.	Hemoglobin

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Year - April 2024

TYBSC-

Mathematics

SEM - V

No. of Pages - 17

TYBSC – Semv – maths

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

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

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

i) Define the double integral of a bounded function $f : S \to \mathbb{R}$ where $S = [a, b] \times [c, d]$ is a rectangle in $\mathbb{R}^2$. Further show with usual notations $m(b-a)(d-c) \leq \iint_S f \leq M(b-a)(d-c)$.

ii) Let U be an open set in $\mathbb{R}^2$ containing the rectangle [a, b] × [c, d]. Suppose f: $U \to \mathbb{R}$ is continuously differential function. Show that $g'(x) = \int_c^d \frac{\partial f(x,y)}{\partial x} dy$ where $g(x) = \int_c^d f(x,y)dy \; \forall x \in [a, b]$.

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

i) Prove that a continuous function is integrable for a rectangular domain in $\mathbb{R}^2$.

ii) Evaluate $\iiint_S 4\, dv$, *where* $S = \{(x, y, z) \in \mathbb{R}^3 : x^2 + y^2 \leq z \leq 1\}$

iii) Evaluate $\iint_S (x^2 + y^2)\, dxdy$ where S is the region in the XY-plane bounded by the curves $x^2 - y^2 = 1,\ x^2 - y^2 = 2, xy = 2, xy = 4$.

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

i) Let U be an open set in $\mathbb{R}^n$ and $\alpha : [a, b] \to U$ be a parameterization of curve Γ. If $f, g : U \to \mathbb{R}$ are continuous function, then prove that

$$\int_\Gamma (cf + dg) = c \int_\Gamma f + d \int_\Gamma g$$

where c, d are real constants. Further show that $\int_\Gamma f = \int_{\Gamma_1} f + \int_{\Gamma_2} f$, where Γ_1 and Γ_2 are restrictions of α to $[a, c]$ and $[c, b]$ where $a < c < b$.

ii) State and prove the Green's theorem for a rectangle.

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

i) Evaluate the line integral of scalar field $f(x, y, z) = x + y + z$ along the curve C with parameterization $\gamma(t) = (\sin t, \cos t, t),\ 0 \leq t \leq 2\pi$.

ii) Use the Greens' theorem to evaluate $\oint_C (y + 3x)dx + (2y - x)dy$ where C is the ellipse $x^2 + \frac{y^2}{4} = 1$.

iii) Evaluate the line integral $\int_C x^2 dx + xy\, dy + dz$, where C is parametrized by $c(t) = (t,\ t^2, 1), 0 \leq t \leq 1$.

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

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i) State Divergence Theorem for a solid in 3-space (or $\mathbb{R}^3$) bounded by an orientable closed surface with positive orientation and prove the Divergence Theorem for cubical region.

ii) For the surface $\bar{r}(u,v)$ described by the vector equation $\bar{r}(u,v) = X(u,v)\hat{i} + Y(u,v)\hat{j} + Z(u,v)\hat{k}, (u,v) \in T$ where X, Y, Z are differentiable on T, define the fundamental vector product $\frac{\partial \bar{r}}{\partial u} \times \frac{\partial \bar{r}}{\partial u}$. If C is a smooth curve lying on the surface, $C = \bar{r}(\propto(t)),\ \propto; [a,b] \to T$, then show that $\frac{\partial \bar{r}}{\partial u} \times \frac{\partial \bar{r}}{\partial u}$ is normal to C at each point.

B) Attempt any two from the following.

i) Let $S = \bar{r}(T)$ be a smooth parametric surface in uv plane. Define area of S. If S is represented by an equation $z = f(x,y)$ then show that area of S is given by (12)

$$\iint_T \sqrt{1 + \left(\frac{\partial f}{\partial x}\right)^2 + \left(\frac{\partial f}{\partial y}\right)^2}\ dxdy.$$

ii) Evaluate surface integral of scalar field f over the surface S where $f(x,y,z) = xyz$, S is the surface of the cone $z^2 = x^2 + y^2$ between $z = 1$ and $z = 2$.

iii) Verify the Gauss Divergence Theorem for $F(x,y,z) = (yz, zx, xy)$ over the surface of the sphere $x^2 + y^2 + z^2 = 9$.

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

i) Reverse the order of integration and evaluate $\int_0^1 \int_{\sqrt{x}}^1 \sqrt{1+y^3}\ dydx$.

ii) State Fubini's theorem and hence evaluate $\iint_D f\ dA$ where $f(x,y) = 5xy$ and D is the region bounded by $x = \pm 1$ and $y = \pm 2$.

iii) Evaluate the following integral by showing it is independent on the path. $\int_{(1,0,0)}^{(0,1,1)} \sin y \cos x\ dx + \cos y \sin x\ dy + dz$.

iv) Using Green's Theorem, find the area of the region D where D is the asteroid $r(t) = (cos^3\ t)\bar{\imath} + (sin^3\ t)\bar{\jmath},\ 0 \le t \le 2\pi$.

v) Evaluate surface area of the surface S cut from the plane $x + y + z = 5$ by the cylinder whose walls are $x = y^2$ and $x = 2 - y^2$.

vi) Using the Stoke's Theorem, evaluate the surface integral $\iint_S (curl\ F) \cdot \bar{n} dS$ where $F(x,y,z) = (x - z, x^3 + yz, -3xy^2)$, S is the surface of the cone $z = 2 - \sqrt{x^2 + y^2}$ above the plane $z = 0$.

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(3)

TY BSC - sem-V - maths

Duration 2 ½ Hrs. Marks: 75

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

1. (a) Attempt **any One** of the following: (8)
   (i) Show that in a metric space (X, d)
   (I) arbitrary union of open sets is open set.
   (II) finite intersection of open sets is open set.
   (ii) Define an open ball $B(x, r)$ in a metric space (X, d) and show that every open ball is an open set. Also give an example to show that the converse need not be true.

   (b) Attempt **any Two** of the following: (12)
   (i) Show that $S = \{x \in \mathbb{Q} : 3 < x^2 < 5\}$ is both open and closed in the subspace $\mathbb{Q}$ of $\mathbb{R}$ with usual metric.
   (ii) (I) Consider the subspace $Y = [0, \infty)$ of $\mathbb{R}$ where distance d in $\mathbb{R}$ is usual. Find $B_Y(0, 5)$ an open ball in the subspace (Y, d).
   (II) In $(\mathbb{R}, \text{usual})$, show that $\mathbb{Q}$ is neither a closed set nor an open set.
   (iii) Consider the norms $\| \ \|_1$, $\| \ \|_2$ and $\| \ \|_\infty$ on $\mathbb{R}^2$ defined as $\|x\|_1 = |x_1| + |x_2|$, $\|x\|_2 = \sqrt{x_1^2 + x_2^2}$ and $\|x\|_\infty = \max\{|x_1|, |x_2|\}$, for any $x = (x_1, x_2) \in \mathbb{R}^2$. Show that for $x \in \mathbb{R}^2$,
   I) $\|x\|_2 \leq \|x\|_1$ II) $\|x\|_1 \leq \sqrt{2}\ \|x\|_2$ III) $\|x\|_\infty \leq \|x\|_2$

2. (a) Attempt **any One** of the following: (8)
   (i) Let (X, d) be a metric space and Y be a non-empty subset of X. Prove that a subset G of Y is open in the subspace (Y, d) if and only if $G = V \cap Y$ where V is an open set in (X, d) .
   (ii) State and prove Nested interval theorem in $\mathbb{R}$.

   (b) Attempt **any Two** of the following: (12)
   (i) Show that in a metric space (X, d) every Convergent sequence is Cauchy. Is the converse true? Justify
   (ii) Show that a sequence (x_n) in $(\mathbb{R}^2, d)$ (where d is Euclidean distance) converges to a point $p = (p_1, p_2) \in \mathbb{R}^2$ if and only if $(x_n^i) \longrightarrow p_i$ for $1 \leq i \leq 2$, in $\mathbb{R}$ with respect to the usual distance, where $x_n = (x_n^1, x_n^2)$.
   (iii) Show that $\mathbb{R}$ is a complete metric space w.r.t. the usual distance.

3. (a) Attempt any One from the following: (8)
   (i) Show that a compact subset of a metric space is closed and bounded. Give an example to show that a closed and bounded subset of a metric space need not be compact.
   (ii) Consider the metric space $(\mathbb{R}, d)$ where d is usual metric, $\emptyset \neq A \subset \mathbb{R}$. Prove that A is sequentially compact if and only if A satisfies Bolzano-Weierstrass property.

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(b) Attempt **any Two** of the following

(i) Check whether the following sets are compact in the given metric spaces:

(I) $S^1 = \{(x,y) \in \mathbb{R}^2 : x^2 + y^2 = 1\}$ in $(\mathbb{R}^2, d)$ where d is usual distance.

(II) $K = \{n + \frac{1}{n} : n \in \mathbb{N}\}$ in $(\mathbb{N}, d)$ where d is usual distance from $\mathbb{R}$.

(ii) Prove or disprove: Interior and closure of a compact set is compact.

(iii) Prove that a subset K in a discrete metric space (X,d) is compact if and only if K is a finite set.

4 Attempt **any Three** of the following:

(a) Let d_1, d_2 be metrics on X. Define $d : X \times X \longrightarrow \mathbb{R}$ as $d(x,y) = \max\{d_1(x,y), d_2(x,y)\}$. Show that d is a metric on X.

(b) Let d_1 and d_2 be metrics on a non-empty set X such that there exist $k_1, k_2 > 0$ such that $k_1 d_1(x,y) \leq d_2(x,y) \leq k_2 d_1(x,y)$, $\forall x, y \in X$. Show that a sequence (x_n) is Cauchy in (X, d_1) if and only if sequence (x_n) is Cauchy in (X, d_2).

(c) Check whether Cantor's theorem is applicable in each of the following examples and find $\cap_{n\in\mathbb{N}} F_n$ in each case, where (F_n) is a sequence of subsets of $\mathbb{R}$ and the distance d is usual distance from $\mathbb{R}$.

(i) $X = [-1,1]$, $F_n = [-\frac{1}{n}, \frac{1}{n}]$, $n \in \mathbb{N}$

(ii) $X = (0,1)$, $F_n = (0, \frac{1}{n+1}]$, $n \in \mathbb{N}$

(d) Prove that in a discrete metric space every Cauchy sequence is eventually constant. Hence deduce that a discrete metric space is complete.

(e) If (X,d) be a metric space and (x_n) be any convergent sequence in X such that (x_n) converges to p then show that $K = \{x_n : n \in \mathbb{N}\} \cup \{p\}$ is compact subset of (X,d).

(f) If A, B are compact subsets of any metric space, prove that $A \cup B$ is also compact.

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(5)

TYBSC - Sem V - Maths

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) Let G be an abelian group of order n. Let m be an integer which is relatively prime to n. Prove that $f: G \to G$ defined by $f(x) = x^m$ is an automorphism of G. Hence determine whether $f: V_4 \to V_4$ defined as $f(x) = x^3$ is an automorphism, where V_4 is Klein 4 −group. 08

ii) Let H and K be subgroups of a group G. Prove that $H \cup K$ is a subgroup of G if and only if $H \subseteq K$ or $K \subseteq H$. Give an example of a group G and its subgroups H and K such that $H \cup K$ is not a subgroup of G. 08

B Answer any **TWO**

i) If H, K are subgroups of a group G then show that HK is a subgroup of G if and only if $HK = KH$. 06

ii) Let G be a group and $a \in G$ be any element. Prove that order of a is equal to the order of a^{-1} in G. Hence deduce that if a is an element of G of order n then for each integer k such that $1 \leq k \leq n$, order of a^k is equal to the order of a^{n-k}. 06

iii) Let G be a group and H be non-empty subset of G. Prove that H is a subgroup of G if and only if $ab^{-1} \in H$ for all $a, b \in H$. 06

Q.2 A Answer any **ONE**

i) Let G be a group. If G is the internal direct product of two of its subgroups H, K then prove that G is isomorphic to the external direct product $H \times K$ of H and K. 08

ii) Let G and G' be groups and $f: G \to G'$ be onto group homomorphism. Prove that, 08
p) $\ker f = \{x \in G: f(x) = e'\}$ is a normal subgroup of G.
q) If H' is a subgroup of G' then $f^{-1}(H') = \{g \in G : f(g) \in H'\}$ is a subgroup of G. If H' is normal in G', prove that $f^{-1}(H')$ is normal in G.

B Answer any **TWO**

i) Let H, K be normal subgroups of G and K be a subgroup of H. Then prove that $\frac{G/K}{H/K}$ is isomorphic to G/H. 06

ii) Prove that A_n is normal subgroup of S_n. 06

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iii) If H_1, H_2 are normal subgroups of groups G_1, G_2 respectively, then prove that $H_1 \times H_2$ is a normal subgroup of $G_1 \times G_2$. 06

Q.3 A Answer any **ONE**

i) p) Let G be a finite group and $a \in G$. Show that $G =< a >$ if and only if the order of a equals the order of the group G. 08

q) Let G be an infinite group and let $a \in G$. If $G =< a >$, then show that order of a is also infinite.

ii) Prove that any infinite cyclic group is isomorphic to $\mathbb{Z}$. Hence, show that any two infinite cyclic groups are isomorphic. 08

B Answer any **TWO**

i) Prove or disprove: If G is a group such that every proper subgroup of G is cyclic, then G has to be cyclic 06

ii) Show that an infinite cyclic group generated by a has exactly two generators a and a^{-1}. 06

iii) Prove that the group of non-zero real numbers under multiplication is not cyclic. 06

Q.4 Answer any **THREE**

i) Let G be a group. 05

p) Suppose that for all $a, b \in G$, $ab = ca$ implies $b = c$. Prove that G is abelian.

q) Suppose that $(ab)^2 = a^2b^2$; for all $a, b \in G$. Prove that G is abelian.

ii) Construct the composition table of the group $U(12)$ of units in $\mathbb{Z}_{12}$ under multiplication modulo 12. Is there a subgroup of order 2 in $U(12)$? If yes, determine it. 05

iii) List all left cosets of the subgroup $H = \{\overline{1}, \overline{17}\}$ of $U(32)$, the group of residue classes under multiplication modulo 32. 05

iv) Let H be a normal subgroup of a group G. If G/H has an element of order n then show that G has an element of order n. 05

v) List all the generators and subgroups of a cyclic group $\mathbb{Z}_{20}$. 05

vi) Let $G =< a >$ be a cyclic group of order 24. Let H be a subgroup of G generated by a^{12} and K be the subgroup generated by a^6. Determine 05
p) The order of a^2H in G/H
q) The order of a^4K in G/K

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(7)

Paper / Subject Code: 24289 / Mathematics : Elective C - Graph Theory (R 2022)

TYBSC - sem V - maths

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. Define a self complementary graph. If G is self complementary graph of order p, show that G is connected and $p \equiv 0$ or $1 \pmod 4$. (8)
   ii. Prove that a non-increasing sequence $S : d_1, d_2, \cdots, d_n$ $(n \geqslant 2)$ of non-negative integers where $d_1 \geqslant 1$ is graphical if and only if the sequence $S_1 : d_2 - 1, d_3 - 1, \cdots, d_{d_1+1} - 1, d_{d_1+2}, \cdots, d_n$ is graphical. (8)

   (b) Attempt any **TWO** questions:
   i. Show that in a party of 6 or more people, either there are 3 persons who know one another or there are three persons who do not know one another. (6)
   ii. Show that a graph G is disconnected if and only if its vertex set V can be partitioned into two subsets V_1 and V_2 such that there exists no edge in G whose one end vertex is in the subset V_1 and the other in the subset V_2. (6)
   iii. Find three nonisomorphic graphs with degree sequence 3,3,2,2,2,2. (6)

2. (a) Attempt any **ONE** question:
   i. State and prove Cayley's formula for spanning trees. (8)
   ii. Define Cut Vertex in a simple graph G. Show that vertex v is a cut vertex if and only if there exists two vertices x and y such that v is on every $x - y$ path in G. (8)

   (b) Attempt any **TWO** questions:
   i. Show that every two vertices of a tree are connected by a unique path. (6)
   ii. Let $\tau(G)$ denote the number of spanning trees of a graph G. (6)
   Use this $\tau(G) = \tau(G - e) + \tau(G.e)$ recurrence formula to find $\tau(K_4 - e)$.
   iii. Describe Breath First Search (BFS) algorithm. Use BFS to find spanning tree for the wheel graph W_n starting at the vertex of degree n where n is integer with $n \geq 3$. (6)

3. (a) Attempt any **ONE** question:
   i. If G is graph on p vertices with $p \geq 3$ and $\delta(G) \geq \frac{p}{2}$ where $\delta(G)$ denotes the minimum degree of G then show that G contains a Hamiltonian cycle. (8)
   ii. Prove that a connected graph G contains Eulerian trail if and only if exactly two vertices of G have odd degree. (8)

   (b) Attempt any **TWO** questions:
   i. Define closure of a graph $C(G)$ and show that a simple graph is Hamiltonian if and only if its closure is Hamiltonian. (6)
   ii. Prove that the cube graph Q_k is bipartite $k-$regular graph with 2^k vertices. (6)

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(m) If G is Hamiltonian graph then for every nonempty proper subset S of $V(G)$, prove that $\omega(G - S) \leq |S|$. Is converse true? Justify.

4 Attempt any **THREE** questions:

(a) If a graph G contains a $u - v$ walk of length l, then show that G contains a $u - v$ path of length at most l.

(b) Let G be a simple graph and $\delta(G) \geq 2$, then show that there exists a cycle of length at least $\delta(G) + 1$ in G.

(c) Define a binary tree. Show that the number of leaves in a full binary tree with n vertices is $\frac{n+1}{2}$.

(d) Describe Kruskal's algorithm for finding minmum spanning tree in a connected weighted graph using an example.

(e) A mouse eats his way through a $3 \times 3 \times 3$ cube of cheese by tunnelling through all of the $27 \times 1 \times 1$ sub-cubes. If he starts at one corner and always move on to an uneaten sub-cube, can he finish at the center of the cube?

(f) Define a line graph of a graph G. Show that the line graph a simple graph G is a path if and only if G is a path.

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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 $|z - z_0| \le R_1$, 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 $\frac{1}{5} \le |z| \le 2$ 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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(11)

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 pth 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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TY BSc

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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(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 $\binom{r+k-1}{r}$. (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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(14) T4BSC sem - V

Paper / Subject Code: 88682 / Mathematics: Graph Theory and Combinatorics (R-2023)

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
   (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.

   (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.
   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 $k-1$.
   iii. Prove that every tree with $n \geq 2$ vertices is 2-chromatic.

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

   (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 $q \leq \frac{n(p-2)}{n-2}$.
   ii. For a plane graph G, prove that G is bipartite if and only if every face of G has even length.
   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.

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 $\frac{n(n+1)}{2} + 1$.
   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 $\forall 1 \leq i_1 < i_2 < ... < i_k \leq n$.

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TYBSC Sem-V

(2 ½ Hours) [Total Marks: 75]

N.B. 1) All questions are compulsory.
2) Figures to the right indicate marks.
3) Illustrations, in-depth answers and diagrams will be appreciated.
4) Mixing of sub-questions is not allowed.

Q. 1 Attempt ANY FOUR from the following: (20M)

(a) Discuss the application areas of LPP.

(b) What is the standard form of an LP problem?

(c) Use the graphical method to solve the following LP problem.
Maximize $Z = 2x1 + x2$
subject to the constraints
(i) $x1 + 2x2 \leq 10$,
(ii) $x1 + x2 \leq 6$,
(iii) $x1 - x2 \leq 2$,
(iv) $x1 - 2x2 \leq 1$
and $x1, x2 \geq 0$.

(d) How is classification done in operation research? Explain predictive & physical model.

(e) Evening shift resident doctors in a government hospital work five consecutive days and have two consecutive days off. Their five days of work can start on any day of the week and their schedule rotates indefinitely. The hospital requires the following minimum number of doctors to work on the given days:

Sun	Mon	Tue	Wed	Thu	Fri	Sat
35	55	60	50	60	50	45

No more than 40 doctors can start their five working days on the same day. Formulate this problem as an LP model to minimize the number of doctors employed by the hospital.

(f) What is linear programming? What are its major assumptions and limitations?

Q. 2 Attempt ANY FOUR from the following: **(20M)**

(a) Explain the steps of Branch and Bound method.

(b) Write the dual to the following LP problem.
Maximize $Z = x1 - x2 + 3x3$
subject to the constraints
(i) $x1 + x2 + x3 \leq 10$,
(ii) $2x1 - x2 - x3 \leq 2$,

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(iii) $2x1 - 2x2 + 3x3 \leq 6$

and $x1, x2, x3 \geq 0$

(c) Write note on the principle of complementary slackness

(d) State the rules for constructing the Dual from Primal.

(e) Write the dual of the following primal LP problems:

Max $Zx = 2x1 + 5x2 + 6x3$

subject to (i) $5x1 + 6x2 - x3 \leq 3$

(ii) $-2x1 + x2 + 4x3 \leq 4$

(iii) $x1 - 5x2 + 3x3 \leq 1$

(iv) $-3x1 - 3x2 + 7x3 \leq 6$

and $x1, x2, x3 \geq 0$.

(f) Draw tree diagram of Integer Linear Programming and explain cutting plane method.

Q. 3 Attempt ANY FOUR from the following: **(20M)**

(a) Explain the difference between LP and GP approach

(b) Write note on 1. Enumeration method 2. Simplex method

(c) Five men are available to do five different jobs. From past records, the time (in hours) that each man takes to do each job is known and is given in the following table:

	JOBS				
	I	II	III	IV	V
MEN A	2	9	2	7	1
B	6	8	7	6	1
C	4	6	5	3	1
D	4	2	7	3	1
E	5	3	9	5	1

Find out how men should be assigned the jobs in way that will minimize the total time taken.

(d) Write a note on transportation problem.

(e) A marketing manager has five salesmen and five sales districts. Considering the capabilities of the salesmen and the nature of districts, the marketing manager estimates that the sales per month (in hundred rupees) for each salesman in each district would be as follows:

	Districts				
	A	B	C	D	E
Salesmen 1	32	38	40	28	40
2	40	24	28	21	36
3	41	27	33	30	37
4	22	38	41	36	36
5	29	33	40	35	39

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Find the assignment of salesmen to districts that will result in maximum sales.

(f) What is duality? What is the significance of dual variables in an LP model?

Q. 4 Attempt ANY FIVE from the following: **(15M)**

(a) Write note on 1. Probabilistic model 2. Deterministic model

(b) How economic Interpretation of Dual Variables does is done?

(c) What is the method of finding an initial solution?

(d) Explain the role of model and modelling in operation research.

(e) Explain sensitivity analysis in Linear Programming

(f) Explain the mathematical model of assignment problem.

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Year - April 2024

TYBSC-

Physics

SEM - V

No. of pages - 12

TYBSc - Sem VI

(1)

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, $M(^{15}_{8}O) = 15.00307$amu,

$m_n = 1.008665$ 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? Given: $m_{p^+} = 1.67 \times 10^{-27}$Kg, $q = 1.6 \times 10^{-19}$C. **05**

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

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

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TYBSc Sem V

Time: 3 hours Marks: 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: Boltzmann Constant: $k = 1.38 \times 10^{-23} J k^{-1}$
Planck's Constants: $h = 6.63 \times 10^{-34} J - s$

Q1. Attempt any **two**

(i) What is a random variable? Consider an experiment of tossing two dices and write the uniform sample space. Consider x = sum of the numbers on the dice, find probability function f(x) for the random variable x. **10**

(ii) Explain the fundamental principle of counting of arranging things in different ways. A club consists of 40 members. In how many ways a president, vice-president, secretary and treasurer can be chosen? In how many ways a committee of 4 members chosen? **10**

(iii) Explain in detail normal or Gaussian distribution? Explain normal approximation to the binomial distribution. **10**

(iv) What is Bernoulli's trial? Explain Binomial Probability function and corresponding cumulative distribution function. **10**

Q2 Attempt any **two**

(i) What is method of separation of variables for solving partial differential equation? Explain the same by solving Heat equation. **10**

(ii) The motion of the transverse wave on a string is given by **10**

$$\frac{\partial^2 \emptyset}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 \emptyset}{\partial t^2}$$

Find the general periodic motion solution of wave equation. Also find the solution $\emptyset(x, t)$ for the initial condition given

$\emptyset(0,1) = \emptyset(L, t) = 0 = \frac{\partial \emptyset}{\partial t} = 0 \; at \; t = 0$

$\emptyset(x, 0) = \text{Sin}\frac{n\pi x}{L}$

(iii) What do you mean by Hyperbolic function in complex number? Hence show that **10**

i) $\cosh^2(z) - \sinh^2(z) = 1$

ii) $\frac{d}{dx}\cosh(z) = \sinh(z)$

(iv) Explain the trigonometric function of a complex number z using these **10**
i) Prove that Sin 2z =2Sin zCos z
ii) Find the value of $\sin(\frac{\pi}{2} + i \ln 2)$

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Q3 Attempt any **two**

(i) Obtain the relation between β and temperature T. What are the unit of kT, where k is Boltzmann constant. 10

(ii) Derive an expression for translation partition function in one dimension and three dimensions. 10

(iii) Show that the entropy S of a system can be written as

$$S = \frac{U}{T} + k \ln Q$$ 10

(iv) What is Boltzmann distribution? Derive its expression. 10

Q4 Attempt any **two**

(i) Derive Maxwell – Boltzmann distribution law of velocities. What is Boltzmann factor? 10

(ii) N number of identical balls are thrown randomly in a box of k – compartments of areas $a_1, a_2, \ldots\ldots\ldots a_k$. Show that in the most probable distribution, the number of particles in a compartment is proportional to the area of that compartment. 10

(iii) Derive Plank's Radiation formula. 10

(iv) Discuss Rayleigh – Jean's law? What is ultraviolet catastrophe? 10

Q5. Attempt any **four**

(i) Three coins are tossed. What is the probability that two are heads and one tail? If at least two are heads, what is the probability that all are heads? 05

(ii) A random variable x takes the values 0, 1, 2, 3, with probabilities 5/12, 1/3 , 1/12 , 1/6 . Compute the mean for x. 05

(iii) Solve:- $y'' - 2y' + y = 2\cos x$ 05

(iv) Find the value of z for cos z = 2 05

(v) Calculate the probability of a simple harmonic oscillator for the first three levels (i.e. $n = 0,1\&2$). 05

(vi) Write a short note on canonical ensemble. 05

(vii) Sunlight arrives at the earth at the rate of 1400 watt/m^2 when the sun is directly overhead. The sun's radius is 6.96×10^8 m and the mean radius of the earth's orbit is 1.49×10^{11} m. Assuming that the sun is a black body, estimate the temperature of the sun. $\sigma = 5.67 \times 10^{-8}$ W/m^2K^4. 05

(viii) In a random distribution of 6 particles between 2 boxes of top areas in the ration 1:2, calculate the probability of distribution of equal number of particles in each box. What is the probability of most probable distribution? 05

TYBSC - Sem V - physics

Time: 3 hrs. Marks: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: Boltzmann Constant: $k = 1.38 \times 10^{-23}\, J/K$
Planck's Constants: $h = 6.63 \times 10^{-34}\, Js$

Q1. Attempt any **two**

(i) Obtain the expression for the divergence and curl of electrostatic field in free space. **10**

(ii) Find the potential of a uniformly charged spherical shell of radius R for points outside the sphere. **10**

(iii) Derive and explain First and second uniqueness theorem. **10**

(iv) Suppose a point charge q is held a distance d above an infinitely grounded conducting plane. What is the potential in the region above the plane? **10**

Q2 Attempt any **two**

(i) Using Ampere's circuital law for an infinite solenoid carrying current I show that the magnetic field is parallel to the axis of the solenoid. Also obtain an expression for magnetic field inside and outside the solenoid. **10**

(ii) Using Biot-Savart's law, show that $\vec{\nabla} \cdot \vec{B} = 0$. Also explain the physical significance of the result. **10**

(iii) Find an expression for electrostatic energy stored in a linear, homogenous and isotropic dielectric material. **10**

(iv) Obtain an expression for the potential due to polarized object in-terms of surface charge density (σ_b) and volume charge density (ρ_b). **10**

Q3 Attempt any **two**

(i) Why do we need to modify Ampere's circuital law? Derive the expression for Maxwell correction to the Ampere's circuital law. **10**

(ii) For the magnetized object containing magnetic moment **m** show that its vector potential leads to the concept of surface and volume bound currents densities $K_b = M \times \hat{n}$ and $J_b = \nabla \times M$ **10**

(iii) Starting with relation $\nabla \times \boldsymbol{B} = \mu_0(\boldsymbol{J_b} + \boldsymbol{J_f})$ for Ampère's law, Derive the relation $\nabla \times \boldsymbol{H} = \boldsymbol{J_f}$ (The symbols have their usual meaning). A long copper rod of radius R carries a uniformly distributed (free) current I. Find **H** inside and outside the rod. **10**

(iv) Prove the following relation for energy stored in magnetic field. **10**

$$W = \frac{1}{2\mu_0}\int_{All\ space} B^2 d\tau$$

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Q4 Attempt any **two**

(i) Consider a wave travelling in a medium with refractive index n_1. If it is to be incident on the medium with refractive index n_2 obliquely. Starting with the boundary conditions, show that the transmission coefficient is given as $T = \alpha\beta\left(\frac{2}{\alpha+\beta}\right)^2$, where symbols have their usual meaning. 10

(ii) Show that $\frac{dw}{dt} = -\frac{\partial}{\partial t}\int_v (u_e + u_m)\, dv - \oint_s \vec{S}.\hat{n}da.$ 10

(iii) Derive the electromagnetic wave equation in vacuum, where there are no free charges or currents. Also show that the electric field, magnetic field and the direction of propagation are mutually perpendicular. 10

(iv) Obtain equation of continuity from the principle of conservation of charge. Determine the Poynting vector, if a 6 mW laser illuminates a spot of radius 2×10^{-10} m. 10

Q5. Attempt any **four**

(i) Define electric flux. State Gauss law in electrostatics. Write any one merit of Gauss law. 05

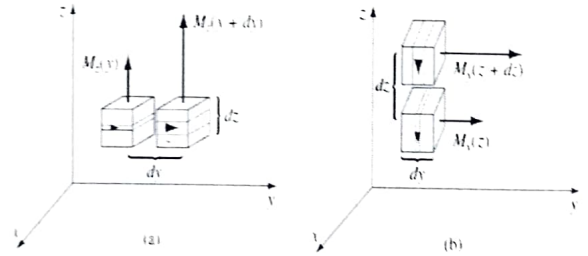
(ii) Determine electric field due to potential $V = 2x^2 + 5y^3 + 6z^4$. 05

(iii) Define energy density for a dielectric system. A uniform electric field 500 V/cm exist in a linear, homogenous and isotropic dielectric of constant 5. Find the energy density stored in the dielectric region. $(\varepsilon_0 = 8.85 \times 10^{-12}\ SI\ units)$ 05

(iv) A vector field in vacuum is given by; $\vec{B} = 2yz\,\hat{x} + 4xz\,\hat{y} + 6xy\,\hat{z}$. Show that it could be a magnetostatic field. Find current density in the field at (3, 4, -5) 05

(v) Choosing the z axis along the direction of magnetization **M**, find the magnetic field of a uniformly magnetized sphere. 05

(vi) Figure (a) and (b) shows two adjacent chunks of magnetized material. Show that the volume bound current density in both case is $\mathbf{J_b} = \nabla \times \mathbf{M}$ 05



(vii) If $\vec{E} = E_0\, e^{i(kz-wt)}\hat{x}$ and $\vec{B} = B_0\, e^{i(kz-wt)}\hat{y}$. Find the energy per unit time per unit area transported by the fields in free space. 05

(viii) An electromagnetic wave is incident normally on the surface of water with refractive index 1.33 from air. Calculate the percentage of incident intensity reflected & transmitted from air. 05

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(7)

Time: 3 hrs. Total Marks: 100

T.Y.B.Sc – Sem VI

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.

1. Attempt any **Two**: -

(i)	Draw and explain the common source drain characterstics of n-channel JFET.	**10**
(ii)	Explain the construction and working of an SCR.	**10**
(iii)	Draw and explain the working of an Enhancement MOSFET.	**10**
(iv)	Explain IV characterstics of UJT with the help of different regions shown in diagram.	**10**

2. Attempt any **Two: -**

(i)	Explain with neat circuit diagram the working of the emitter coupled differential amplifier with single ended output and double ended output.	**10**
(ii)	Explain with the help of necessary circuit diagram the AC analysis open emitter couple differential amplifier with single ended input and differential output and single ended output. Derive an expression for its output voltage gain.	**10**
(iii)	Explain the working of Wein Bridge Oscillator using Op-Amp. State the expression of its fundamental frequency, gain and feedback factor.	**10**
(iv)	Draw a neat circuit diagram of the basic configuration of instrumentation amplifier using three of Op Amps. Explain its working and derive an expression for its CMRR.	**10**

3. Attempt any **Two: -**

(i)	Explain with the help neat circuit diagram transistorized bistable multivibrator.	**10**
(ii)	Explain with the help of neat circuit diagram and relevant waveforms astable multivibrator using IC 555 timer. Derive an expression for its frequency of oscillation and duty cycle.	**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 voltage regulator with fold back current limiting arrangement. Derive an expression for its output current and power dissipation under short circuit conditions.	**10**

4. Attempt any **Two: -**

(i)	Explain two – input Transistor Transistor Logic NOR gate.	**10**
(ii)	Explain CMOS characteristics in terms of sinking, floating inputs and transfer characteristics.	**10**
(iii)	Explain Basic Pulse Code Modulation and Companding process to overcome problems of distortion and noise in the transmission of audio signals.	**10**
(iv)	Explain benefits of digital transmission.	**10**

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5 Attempt any Four: -

(i) Explain the use of JFET as multiplexer.

(ii) A silicon unijunction transistor has an intrinsic standoff ratio 0.65, inter base resistance 10kΩ and V_{BB} = 10 V. calculate the values stand off voltage and peak point voltage.

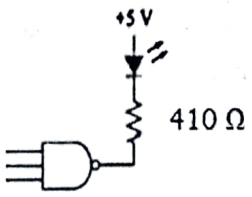
(iii) A differential amplifier with double ended input and double ended output has r_e = 125 Ω for each transistor. Determine the values of R_C and R_E to get A_D = 500 and CMRR = 80 dB.

(iv) In an Op-Amp astable multivibrator has R = 820 Ω, C = 0.22 µF, R_1 = 20 kΩ, R_2 = 2 kΩ. Find frequency of output signal. If V_{CC} = +15 V, find output voltage.

(v) Explain with the help neat circuit diagram IC 555 timer as pulse width modulator.

(vi) The Schmitt trigger using discrete components has V_{CC} =10 V, $V_{CE\ (SAT.)}$ = 0. 2 V, V_{BE} = 0.6 V, R_{L1} = 6.8 kΩ, R_{L2} = 2.2 kΩ and R_E = 1 kΩ. Find the values of switching levels UTL, LTL and hysteresis voltage.

(vii) A TTL circuit drives an LED. When the TTL output is high, the LED is dark. When the TTL output is low, the LED lights up. If the LED voltage drop is 1.5 V, Calculate LED current for a low TTL output.



(viii) The input voltage of a compander with a maximum voltage range of 1.2 V and a µ of 255 is 0.25. What are the output voltage and gain?

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(3 Hours) [Total Marks: 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) Beginning with the time independent Schrodinger's equation for one electron atom, obtain three independent equations in spherical polar coordinates. **10**

(ii) Discuss quantization of orbital angular momentum with respect to magnitude and direction. **10**

(iii) Explain Radial probability density of an electron in hydrogen atom needed using suitable graphs. Also discuss Azimuthal and Zenith probability densities. **10**

(iv) Describe the experimental setup of Stern Gerlach's experiment and explain how it was able to prove the existence of intrinsic spin of electron. **10**

Q2 Attempt any **two**:---

(i) Show quantum mechanically that an electron undergoing transition from higher energy level E_m to a lower energy level E_n emits a radiation of frequency $\nu = \frac{E_m - E_n}{h}$. Also state selection rules for the allowed transition. **10**

(ii) Explain in detail, the experimental set up to observe Zeeman effect and comment on observed Zeeman components. **10**

(iii) Explain on the basis of vector atom model, simultaneous quantization of L, S and J vectors of one electron atom. **10**

(iv) Explain with classical theory Normal Zeeman effect. **10**

Q3 Attempt any **two**:---

(i) Write the expression for vibration-rotation energy levels of a rigid diatomic molecule. Discuss features of P- branch and R-branch using suitable energy level diagram **10**

(ii) Write an expression for rotational energy of a single diatomic molecule. Explain in detail how the energy levels get modified if the effect of bond elongation is taken into consideration. Draw appropriate energy level diagram. **10**

(iii) Draw a labelled schematic diagram of an absorption IR spectrometer and explain its parts. **10**

(iv) State Franck-Condon Principle. Using the principle, explain the electronic spectra of diatomic molecule. **10**

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Q4 Attempt any **two**:---

(i) Define Raman shift and list the observations related to Raman effect

(ii) Explain the Raman activity of water molecules by considering various modes of vibrations

(iii) Discuss pure vibrational Raman spectrum. Also explain stokes and antistokes lines that are observed

(iv) Explain the parts of an ESR spectrometer and discuss its working.

Q5 Attempt any **four**:---

(i) Write Lz using spherical polar co-ordinates and obtain its eigen values.

(ii) A beam of electrons enters a uniform magnetic field, of magnitude 1.2 T. Find the energy difference between electrons whose spins are parallel and anti parallel to the applied field.
Given: h= 6.63 x 10^{-34} Js, c = 3 x 10^{8}m/s, e = 1.6 x 10^{-19}C , m = 9.11 x 10^{-31}Kg

(iii) Spectral lines from 3P-3S transition in sodium atom splits up into two components of wavelength 5890AU and 5896AU due to spin orbit interaction. Estimate the magnetic field experienced by the spinning electron in 3P state due to its orbital motion.
Given: h= 6.63 x 10^{-34} Js, c = 3 x 10^{8}m/s, e = 1.6 x 10^{-19}C , m = 9.11 x 10^{-31}Kg

(iv) Define Lande's 'g' factor and find its value for $^{2}P_{3/2}$.

(v) In a CO molecule, the bond length is 1.13 AU, and the masses of C and O atoms are 1.99 x 10^{-26} Kg and 2.66 x 10^{-26} Kg respectively. Calculate the moment of inertia of the CO molecule and the energy of the first rotational energy level.
Given: h= 6.63 x 10^{-34} Js

(vi) State the principle involved in microwave spectroscopy. Also draw block diagram for Microwave Spectrometer.

(vii) A stokes line of wavelength 5540 AU was observed in a Raman spectrum when radiation of wavelength 5460AU was scattered by a medium. Calculate the Raman shift and wavelength of corresponding Anti-Stokes line. Given :- speed of light = 3 x 10^{8} m/s

(viii) Calculate the resonance frequency in an NMR spectrometer experiment when a field of 2.3487 tesla is applied to a sample of hydrogen nuclei. Lande's g-factor for hydrogen is 5.585.
Given: - h = 6.62 X 10^{-34} Js , μ_N = 5.05 x 10^{-27} JT^{-1}.

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(iv) What is Hall effect? Derive the expression for the Hall voltage and Hall coefficient. Discuss significance of Hall coefficient. **10**

Q4 Attempt any **two**

(i) Explain BCS theory of superconductors. **10**

(ii) What are superconductors? Explain the types of superconductors. **10**

(iii) State the 'law of junction' in p-n junction. Derive the same stating clearly the assumptions made. **10**

(iv) Show the complete volt ampere characteristic of p-n junction diode. Explain how they depend on temperature. **10**

Q5. Attempt any **four**

(i) Lattice constant of copper is 0.38 nm. Calculate the distance between (110) planes. **05**

(ii) Zinc has hcp structure. The height of unit cell is 0.494 nm, the nearest neighbor distance is 0.27 nm, the atomic weight of zinc is 65.37. Calculate the volume of the unit cell. **05**

(iii) Discuss electrical conductivity of metal on the basis of quantum theory of metals. **05**

(iv) At what temperature we expect a 10% probability the electrons in silver have an energy which is 1% above the Fermi energy (E_F = 5.5 eV for silver). **05**

(v) An electric field of 100V/m is applied to the sample of n-type semiconductor whose hall coefficient is found to be – 0.0125 m^3/C. Determine the current density in sample. Given: mobility of electron is 0.36 m^2/VS. **05**

(vi) Consider a germanium p-n junction at 300°K with doping concentration $N_V = 1.5 \times 10^{18}\, cm^{-3}$ and $N_D = 2 \times 10^{15} cm^{-3}$ in the p and n sides of the junction. Determine the contact potential across the junction. The intrinsic carrier concentration of Germanium $n_i = 2 \times 10^{13}\, cm^{-3}$ at 300°K. **05**

(vii) Write a note on London equation in superconductors. **05**

(viii) A germanium p-n junction has reverse saturation current, I_0 = 2 μA at 27°C. Find its dynamic resistance for an applied forward bias of 0.3 V at 27°C. **05**

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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:

Charge of an electron e = 1.6021×10^{-19} Coulomb, Mass of an electron me = 9.11×10^{-31} kg
Boltzmann constant k = 1.38054×10^{-23} Joule/Kelvin, Planck's constant h = 6.626×10^{-34} joule sec
Permeability of free space $\mu_0 = 4 \times 10^{-7}$ Henry/m, Avogadro's number $N_A = 6.023 \times 10^{26}$ /kg mole

Q1. Attempt any **two**

(i) Explain the following terms, (i) Crystal lattice (ii) Basis (iii) Coordination number (iv) Atoms per unit cell and (v) Atomic radius for a simple cubic crystal. **10**

(ii) Define packing fraction. Determine packing fraction for an hcp structure. **10**

(iii) Show that for a simple cubic lattice the interplaner spacing between two parallel planes with miller indices (h k l) is **10**

$$d_{hkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$$

(iv) Derive an expression for the diffraction condition in terms of reciprocal lattice vector and explain it. **10**

Q2 Attempt any **two**

(i) Explain relaxation time, collision time and mean free path as applied to free electrons in a metal. **10**

(ii) Discuss the various drawback of classical free electron theory of metals and explain the assumptions made in the quantum theory to overcome them. **10**

(iii) Discuss the phenomenon of thermionic emission in metals. Obtain Richardson – Dushman equation for the thermionic emission current density at temperature T. **10**

(iv) Derive the expression of Fermi energy and average energy of electron gas at absolute zero. Assume the expression of density of sates. **10**

Q3 Attempt any **two**

(i) Using Kronig-Penny model, obtain solution of Schrodinger's equation for an electron in a periodic potential. **10**

(ii) Explain the Brillouin zones in one dimension and two dimensions with neat diagram. How are they related to the energy levels of an electron in a metal? **10**

(iii) Apply the continuity equation to find the expression for injected minority carries concentration in a bar of semiconductor subjected to radiation at one end as a function of distance under the state of equilibrium. **10**

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(iv) What is Hall effect? Derive the expression for the Hall voltage and Hall coefficient. Discuss significance of Hall coefficient. **10**

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(iv) At what temperature we expect a 10% probability the electrons in silver have an energy which is 1% above the Fermi energy (E_F = 5.5 eV for silver). **05**

(v) An electric field of 100V/m is applied to the sample of n-type semiconductor whose hall coefficient is found to be – 0.0125 m^3/C. Determine the current density in sample. Given: mobility of electron is 0.36 m^2/VS. **05**

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(vii) Write a note on London equation in superconductors. **05**

(viii) A germanium p-n junction has reverse saturation current, $I_0 = 2\ \mu A$ at 27^0C. Find its dynamic resistance for an applied forward bias of 0.3 V at 27^0C. **05**

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Time: 3 hrs.

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$$d_{hkl} = \frac{a}{\sqrt{h^2 + k^2 + l^2}}$$

(iv) Derive an expression for the diffraction condition in terms of reciprocal lattice vector and explain it. 10

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(ii) Explain the Brillouin zones in one dimension and two dimensions with neat diagram. How are they related to the energy levels of an electron in a metal? 10

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Year - April 2024

TYBSC -

Zoology

SEM - V

No. of Pages - 4

(1)

TYBSC - Semv - Zoology

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

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) Levels of organization
b) Types of symmetry
c) Six kingdom classification

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

a) Distinguishing features of class Calcarea and Demospongiae with suitable example.
b) General characters of phylum Cnidaria and distinguishing features of class Anthozoa.
c) General characters of phylum Platyhelminthes and description of *Taenia solium*.

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

a) Distinguishing features of class Hirudinea with reference to Leech
b) General characters and classification of phylum Annelida
c) Distinguishing features of class Ophiuroidea with reference to Brittle Star

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

a) Respiratory system of *Sepia*
b) Female Reproductive system of *Sepia*
c) External characters and importance of Mantle cavity in *Sepia*

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

a) Plasmodium
b) Trichinia worm
c) Millipede
d) Habit and habitat of *Sepia*
e) Cercaria larva
f) Locomotion in *Sepia*

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TYBSc – sem V – zoology

[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) Layers of cell of Epidermis
b) T.S of small intestine
c) V.S. of tooth

Q. 2 Explain Any Two of the following: (20)
a) OECD guidelines for testing of chemicals
b) Hepatotoxicity.
c) Mycotoxin

Q. 3 Give an account on Any Two of the following: (20)
a) Causes and effects of jaundice
b) Cloudy swelling
c) Types of necrosis.

Q. 4 Describe Any Two of the following: (20)
a) Probability – Addition rule
b) Normal Distribution curve
c) Levels of significance and testing of hypothesis

Q. 5 Write short notes on: (Any Four) (20)
a) T.S. of Stomach
b) LC_{50}.
c) Chronic Toxicity.
d) Correlation coefficient
e) T.S. of Liver
f) Gas gangrene

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TYBSc - Sem V - Zoology

[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) Types of plasma proteins and their functions
b) Mechanism of blood clotting
c) Hemoglobin formation and degradation

Q. 2 Explain Any Two of the following: **(20)**
a) Liver Function tests (Any three)
b) Microscopic Examination of blood for myeloma and lymphoma
c) Purpura-Types and diagnosis

Q. 3 Give an account on Any Two of the following: **(20)**
a) The first line defense mechanism of innate immunity
b) Lymph node as a secondary lymphoid organ
c) The basic structure of Immunoglobulin

Q. 4 Describe Any Two of the following: **(20)**
a) Mancini and Ouchterlony methods of immunodiffusion
b) Latex agglutination and Coombs test
c) Classification of vaccines

Q. 5 Write short notes on: (Any Four) **(20)**
a) Functions of WBC
b) Thalassemia and its diagnosis
c) Hapten
d) MHC compatibility in organ transplantation
e) Forensic hematology
f) Dendritic cells

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T4BSC Sem V

Paper / Subject Code: 24254 / Zoology: Anatomy & Developmental Biology

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) Scales in fishes
b) Poison and uropygial gland.
c) Epidermal derivatives Horn and Hoof.

Q. 2 **Explain Any Two of the following:** (20)
a) Structure, function and chemical composition of bone.
b) Structure and function of hyoid bone.
c) Bones of hind limb

Q. 3 **Give an account on Any Two of the following:** (20)
a) Triceps brachii
b) Flexors and extensor muscles
c) Soleus muscle

Q. 4 **Describe Any Two of the following:** (20)
a) 24 hours chick embryo.
b) Spemann Mangold experiment
c) Morphogenesis Movement.

Q. 5 **Write short notes on: (Any Four)** (20)
a) Wart in toad
b) Common skeleton of rib
c) Bicep brachii
d) Cell adhesion
e) Cervical vertebra
f) Fertilization

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